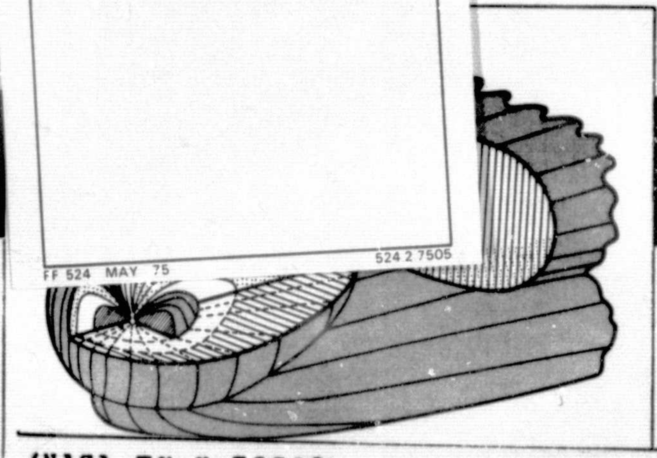

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IMS/Satellite Situation Center Report

Special IMS Periods for 1976

REPORT NO. 6

DECEMBER 1975

NSSDC
WDC-A-R&S

National Space Science Data Center/
World Data Center A for Rockets and Satellites
Code 601
Goddard Space Flight Center
Greenbelt, Maryland, U.S.A. 20771

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I. INTRODUCTION

To assist the International Magnetospheric Study (IMS) Steering Committee in defining a 1976 program of magnetospheric observations in which emphasis would be placed on coordinated measurements of satellites, rockets, balloons, aircraft, and ground-based stations, the Satellite Situation Center (SSC) prepared the material presented in this report. This consists of three main elements. The first element is the position of currently operating high-altitude spacecraft in the Geocentric Solar Ecliptic (GSE), Geocentric Solar Magnetospheric (GSM), and Solar Magnetic (SM) coordinate systems to determine their passage through the bow shock, the magnetopause, the cusp, or the neutral sheet region. The second element consists of information on the synchronous and low-altitude spacecraft and experiments in tabular form; and the third gives a brief tabular summary of all the rocket, balloon, and aircraft campaigns in 1976 as determined from the IMS Directory No. 2. On the basis of this information, updated by personal knowledge of some Steering Committee members, the Steering Committee selected 18 Special Time Periods totaling 587 hours. The announcement of these Special Time Periods was made through a four-page letter, dated December 1975, sent by the Special Committee on Solar-Terrestrial Physics (SCOSTEP) Secretariat to the scientific and administrative personnel associated with the IMS. This SSC report is intended to give the detailed characteristics of those 18 periods and to present the information known about all the satellite, rocket, balloon, and aircraft programs during these times so that maximum coordination can be achieved. It is recognized that certain projects may not need any coordination beyond that for which they have already made arrangements or that certain projects cannot alter their schedules in such a short time to take advantage of making simultaneous observations.

The techniques required to effectively coordinate such a multinational scientific effort as the IMS are not completely understood at this time, and 1976 should be a good year to lay the foundation for such coordination. Since the peak efforts for the IMS will occur in 1977 and 1978, when all the specialized, dedicated spacecraft will have been launched, it is important to give maximum attention to the communication needed for suitable coordination and to establish the most effective SSC outputs that can help to achieve the scientific goals of the IMS.

As one reads this report, one will notice some slight differences in the length of the time periods identified here and those given in the December 1975 announcement. In preparing the additional plots to illustrate the orbital positions of the currently operating high-altitude satellites, more accurate information on the crossing times of the bow shock, the magnetopause, and the neutral sheet regions was obtained. The originally announced total time was 592 hours instead of 587 hours. With that minor exception, however, the information presented here is an amplification of the previous communication and should provide the information necessary to take administrative, technical, and logistic actions that will further the IMS program.

It should be made very clear that those measurements that are potentially possible during the Special Time Periods have been identified. However, because of priorities of data acquisition facilities and of the funding of certain programs, all such measurements may not be made. It has been the intent of the SSC to identify the present situation of the possibly useful spacecraft experiments so that the IMS Steering Committee and others can take administrative action where necessary to have the data acquired, processed, analyzed, and made available in a suitable time frame to the IMS community.

Only after discussions between the various groups planning measurements in 1976, and after decisions on certain administrative requests have been made, will the IMS program for 1976 be defined. The communication of these plans to the newly identified temporary office of coordination* at World Data Center A for Solar Terrestrial Physics in Boulder, Colorado, or Dr. Paul Simon at the *Observatoire de Meudon* will allow interested parties to have an update of what appears in this document -- the real program as opposed to the possible program.

II. SPECIAL IMS SATELLITE PERIODS

High-altitude satellites pass through many interesting regions of the magnetosphere. In particular, the interplanetary medium, the bow shock, the magnetosheath, the magnetopause, and the magnetotail regions are accessible for in situ measurements. Hawkeye 1, being in a highly inclined orbit, also has access to the high-altitude cusp or cleft region. When the high-altitude satellites make measurements on certain regions simultaneously, there is a greater possibility of understanding certain morphology or the detailed physical processes better than from the observations of one satellite. The Special IMS Satellite Periods have been selected at times when two or more of the following satellites are expected to be in interesting regions simultaneously: IMP-H, IMP-J, Vela 5B, and Hawkeye 1. The positions of Velas 6A and 6B have also been included, but less emphasis should be placed on them because of the nature of their operable experiments.

The near-Earth space is broken up into the nine regions given in Table 1 along with the two important boundaries, the bow shock and the magnetopause. The boundaries are also considered regions since the terminology of simultaneous boundary crossings in this report means that two or more satellites will cross the idealized boundary within 2 hours of each other. The definitions for these regions are given in Table 1 and, as such, represent idealized positions. The bow shock and magnetopause positions used are those of Fairfield (1971) for a 420 km/sec solar wind velocity. It is recognized that the true position of such regions may vary by several Earth Radii and that the cusp has been observed some 20°-25° lower during disturbed times. These realities are taken into account by extending any interesting period by approximately 6 hours on

*Established as the Temporary IMS Central Information Exchange Office (TIMSCIE).

each side of the idealized start and end times. Note in the figures the expression, "Time Period," denotes the approximate times of useful encounters and differs from "Special IMS Periods" by these added times. The symbols for the 11 regions shown in Table 1 will be used on all the subsequent plots to identify the position of each satellite; and therefore, the reader should become familiar with them or plan to refer frequently to Table 1.

The 18 Special Satellite Periods chosen by the IMS Steering Committee are given in Table 2, both in calendar days with universal time (UT) and in days of the year (Jan. 1 = Day 1) with UT. One sees that Periods 1-8 and 18 occur during Northern Hemisphere winter with 9 and 15-17 being in late fall. Periods 10-14 occur during the Southern Hemisphere winter. The duration of each Period is given to assist in planning and to emphasize that one is making a conscious effort to minimize the data acquisition necessary from older spacecraft to satisfy the IMS requirements.

To present a rapid visualization of the positions of the ensemble of high-altitude satellites, the regions of space that each satellite occupies for a given period are shown in Table 3. Many of the periods involve more than one interesting conjunction. Each one of these is given by a separate time in Table 3. Thus for Period No. 6 on Day 53 (Feb. 22) at 0400 UT, IMP-J and Hawkeye 1 are within 2 hours of the idealized magnetopause boundary; IMP-H is in the high-latitude magnetotail; and Velas 5B, 6A, and 6B are all within 2 hours of a bow shock crossing. In the case of Hawkeye 1, there are times when it approaches the bow shock (Periods 9, 11, 14, 17, 18) without ever crossing because of the apogee altitude of this spacecraft. The bold face symbols are used to denote which satellites make a given Period a special one.

One may be more interested in a particular type of satellite conjunction than in a time period when the different ones occur. In this case one should refer to Table 4, which shows the times for multiple bow shock crossings, multiple magnetopause crossings, multiple neutral sheet passes, or simultaneous neutral sheet and cusp region passes without identifying the spacecraft involved.

A summary of the experiment packages carried by the high-altitude satellites considered in the determination of the Special Periods is given in Table 5.

III. SATELLITE PLOTS DURING SPECIAL PERIODS

Satellite plots for the Special Satellite Periods are shown in Figures 1 through 129. For the multiple satellite plots, three projections are used where appropriate. To show the relationship between satellite position, the magnetopause, and the bow shock, the GSE coordinate system is used. The GSE system is geocentric with the X-axis along the Earth-Sun line (toward the Sun) and the Z-axis perpendicular to the ecliptic plane such that the Y-axis is toward dusk. The GSE X-Y plane is shown (e.g., Figure 1) with the boundary positions. The satellite position-vector is rotated into this plane to show the relative positions of satellite and boundary. For positive X_{GSE}, a spherical rotation of the satellite position vector is performed at constant ecliptic longitude. For negative X_{GSE}, a rotation of the Y and Z components is performed at constant X_{GSE}.

For each trajectory, time ticks are shown encompassing a boundary crossing. In the table directly beneath the plot, the regions in which the satellites are at these times are shown. In the lower table, the times of the boundary crossings are shown, together with the direction of the pass (In: Inbound pass, and Out: Outbound pass) and the GSE latitude.

To show the relationship between the satellite position and the cusp region (Heikkila 1972), the SM coordinate system is used. In the SM system, the Z-axis contains the North Magnetic Pole, and the Y-axis is perpendicular to the Earth-Sun line toward dusk. The projection used (e.g., Figure 2) is magnetic latitude versus magnetic local time, and the cusp region is shown as a rectangular box according to the definition given in Table 1. Of those satellites considered, only Hawkeye 1 enters the cusp region during undisturbed times. Time ticks are shown on the plot corresponding approximately to entry and exit from the cusp region, and the altitude range covered is shown in the table below the plot.

To show the relationship between the satellite position and the neutral sheet, the GSM coordinate system is used. In the GSM system, the X-axis is along the Earth-Sun line toward the Sun ($X_{GSM} = X_{GSE}$), and the X-Z plane contains the geomagnetic dipole such that the Y-axis is toward dusk. A simple neutral sheet model is assumed such that the sheet is pinned onto the geomagnetic equator at $X_{SM} = -10R_E$ and lies in a plane parallel to the X-Y GSM plane. The projection shown (e.g., Figure 3) is the Y-Z GSM plane. The neutral sheet positions are indicated by horizontal lines for various values of UT. The horizontal extent of these lines has no significance. Time ticks are shown corresponding to entry and exit from the region of the neutral sheet (Table 1), and the altitude ranges are shown in the table beneath the plot.

In the three projections described above, satellite trajectories or portions of trajectories shown as broken lines are presented for interest and do not, in a given projection, contribute to the Special Period of interest.

There are certain limitations to the projections described above. For the GSE projection, it is not easy to tell from the plot at precisely what time the boundary intercept occurs. Further, because of the rotations performed on the satellite position vector, occasionally the satellite appears to be in a region in which it is not. For the region $X_{GSE}<0$, for which a cylindrical rotation is performed, the inherent assumption is that the boundaries are cylindrically symmetric. The boundaries, however, are aberrated 4°, introducing an insignificant error for the magnetopause, but potentially a significant error for the bow shock. For $X_{GSE}>0$, the inherent assumption is that the boundaries are spherically symmetric. Again, there is a small error introduced for the magnetopause intercepts, but a potentially large error for the bow shock intercepts that occur for the high-inclination satellites such as Hawkeye 1. An example of this may be seen in Figure 56, where, from the plot, it appears that Hawkeye 1 is in the interplanetary medium for approximately a 14-hour period. In fact, Hawkeye 1 does not leave the dayside magnetosheath during this period, and the apparent effect results from the rotation of the position vector. For the satellite trajectories presented here, the effect is significant only for Hawkeye 1 bow shock crossings, and users of SSC Report No. 2 should be aware of this effect.

In order to correct the above effect and to show the precise time of intercept, the plots of the type shown in Figure 108 are presented. The ordinate in the upper plot is the distance between the boundary and the satellite, 'B' corresponding to the bow shock and 'M' corresponding to the magnetopause. The actual distance plotted is shown in the inset figure on Figure 108. For either boundary (the inset figure shows the bow shock), a normal is drawn to the boundary at the intercept point, and the plotted distance is the projection of the satellite position A onto this normal. The sign convention adopted is such that the distance is negative for satellite radii greater than the boundary geocentric distance and positive for radii less than the boundary distance. The boundary positions were determined from the expression:

$$AX^2_{GSE} + BX_{GSE}Y_{GSE} + CX_{GSE} + DY_{GSE} + Y^2_{GSE} + Z^2_{GSE} + E = 0,$$

where the coefficients were taken from Fairfield (1971) for a 420 km/sec solar wind speed. The Z^2_{GSE} term has been added to Fairfield's equation. For the small number of cases for which the rotation effect described above is important, corrections have been made to the tables below the GSE plots. The ecliptic latitude and longitude of the satellite are shown in the lower half of each plot.

An additional value of the boundary plots of the type shown in Figure 108 is that they may be used to assess the effect of the motion of the boundaries caused by variations in the solar wind conditions. An illustration of this is given in Figures 107 through 110 for Time Period 16. This time period has been designated as a Special Period because of nearly simultaneous intercepts of the magnetopause boundary (see Table 3). These intercepts are marked P_0 on Figures 107 through 110 and occur at the times shown below:

Satellite	Pass	P_0	P_1	P_2
Vela 5B	Outbound	16.5h	13.5h	20.0h
Vela 6A	Outbound	13.0h	10.0h	16.5h
IMP-J	Inbound	13.0h	18.5h	8.0h
Vela 6B	Inbound	14.0h	17.0h	10.0h

The effect of the magnetopause symmetrically shrinking or expanding 1.5 Earth Radii can be assessed by moving the axis, respectively, up or down 1.5 Earth Radii and observing the intercept times for the intercepts P_1 and P_2 shown in Figures 107 through 110. These times are shown in the above table, and it can be seen that for this example nearly simultaneous measurements of the disturbed magnetosphere boundary can be expected from Vela 6B and IMP-J.

For the GSM projection (e.g., Figure 3), it is not easy to determine the precise entry and exit times for the neutral sheet region or the X_{GSM} value for the region measured. Neither is it evident where the satellites are in the mid- or high-latitude magnetotail. To enable easy access to this information, the plots of the type shown in Figure 12 are presented. In the upper plot the parameter $Z_{GSM} - Z_{Sh}$ is plotted, and in the lower plot the parameters X_{GSM} and Y_{GSM} are shown.

IV. BRIEF DESCRIPTIONS OF THE SPECIAL PERIODS

In this section a brief description of each Special Period is given. In addition to the high-altitude satellites, consideration is given to five synchronous satellites: ATS 5, ATS 6, SMS 1, SMS 2, and GOES 1. The variation of local time of these satellites with UT is shown in Figure 130. In addition, it is noted that ISIS 2, AE-C, AE-D, and ISS, which will be launched February 1976 by Japan, are low-altitude polar satellites that will pass through the low-altitude cusp region during those periods when the high-altitude satellites are in the magnetotail, and it is likely they will be in the cusp when Hawkeye 1 is in the high-altitude cusp region. In addition, it should be noted that SOLRAD 11A and 11B will be launched in late February or early March 1976 and will provide additional high-altitude coverage. The magnetospheric experiments for each of the above spacecraft are listed in Table 6 with the latest status information available at the SSC. More details for each of these experiments can be found in the 1975 Report on Active and Planned Spacecraft and Experiments, January 1975, NSSDC/WDC-A-R&S 75-01 and the Supplement, July 1975, NSSDC/WDC-A-R&S 75-06.

IV.1 SPECIAL PERIOD 1: DAY 2/16h - DAY 4/16h

Four separate conjunctions occur during this time period. From Figures 2 and 3, it may be seen that there is simultaneous observation of the cusp and the neutral sheet over the time period Day 3/1h - Day 3/5.5h. Additionally, from Figure 130, it may be seen that ATS 6 passes through local midnight during this time period. The neutral sheet passes of the Vela 5B and 6A satellites are shown in Figures 12 through 14. From Figure 1, it can be seen that there are three opportunities to perform multiple boundary observations during this time period. At approximately Day 3/20h, Vela 5B (Figure 5) and Vela 6B (Figure 6) are both at the magnetopause; at approximately Day 4/1h, IMP-H (Figure 4) is at the bow shock, and Hawkeye 1 (Figures 7 and 11) and Vela 6A (Figure 10) are at the magnetopause; and at approximately Day 4/10h, Vela 5B (Figure 8) and IMP-J (Figure 9) are both at the bow shock.

IV.2 SPECIAL PERIOD 2: DAY 13/0h - DAY 13/13h

Only boundary plots are shown for this time period, and it may be seen that IMP-H (Figure 15) and Vela 5B (Figure 16) are both at the magnetopause at approximately Day 13/6h.

IV.3 SPECIAL PERIOD 3: DAY 25/13h - DAY 26/24h

Two separate conjunctions occur during this time period. At approximately Day 25/19h, IMP-J (Figure 19) and IMP-H (Figure 20) are both at the magnetopause. From Figure 18, it may be seen that three satellites are in the neutral sheet over the time period Day 26/6h-7h. Further, IMP-H is in the sheet at the same time as one Vela satellite, giving good spatial distribution through the sheet over the time interval Day 26/6h-16h. Neutral sheet plots for the three satellites are shown in Figures 21 through 23.

IV.4 SPECIAL PERIOD 4: DAY 27/23h - DAY 28/13h

Only boundary plots are shown for this time period, and it may be seen that IMP-H (Figure 24) and IMP-J (Figure 25) are both at the magnetopause.

IV.5 SPECIAL PERIOD 5: DAY 39/15h - DAY 40/20h

Multiple neutral sheet observations are made during this time period. From Figure 26, it can be seen that three satellites are in the neutral sheet between Day 40/0h and Day 40/2h. Further, IMP-J and one Vela are in the sheet over the interval Day 40/0h-4h giving good spatial distribution. Further, as seen from Figure 130, ATS 6 is at local midnight during this time period. Neutral sheet plots are shown in Figures 27 through 31.

IV.6 SPECIAL PERIOD 6: DAY 52/21h - DAY 54/1h

During this time period, there are two opportunities to make multiple boundary observations. At approximately Day 53/4h, Hawkeye 1 (Figure 33) and IMP-J (Figure 34) are at the magnetopause; and Vela 6B (Figure 36), Vela 6A (Figure 35), and Vela 5B are at the bow shock. At approximately Day 53/19h, IMP-H (Figure 37) and Vela 6A (Figure 35) are at the magnetopause.

IV.7 SPECIAL PERIOD 7: DAY 62/7h - DAY 64/2h

During this time period, there are two opportunities to make multiple boundary observations. At approximately Day 62/14h, Vela 6A (Figure 41) is at the bow shock, and IMP-J (Figure 42) is at the magnetopause. At approximately Day 62/24h, Hawkeye 1 (Figure 43) and Vela 5B (Figure 45) are at the magnetopause, and IMP-H (Figure 44) is at the bow shock. Note that IMP-J is in the neutral sheet at this time. From Figures 39 and 40, it is evident that Hawkeye 1 is in the cusp and IMP-J is in the neutral sheet over the period Day 63/0h - 5.5h. From Figure 130, it may be seen that ATS 6 is at local midnight during this time period. IMP-J neutral sheet plots are shown in Figures 46 and 47.

IV.8 SPECIAL PERIOD 8: DAY 66/5h - DAY 67/15h

At approximately Day 66/11h, IMP-H (Figure 50) is at the magnetopause, and IMP-J (Figure 51) is at the bow shock. At approximately Day 67/6h, IMP-H (Figure 52) and Vela 6A (Figure 53) are at the bow shock, and Hawkeye 1 (Figure 55) is at the magnetopause. From Figure 49, it is clear that Hawkeye 1 enters the cusp region after crossing the magnetopause boundary.

IV.9 SPECIAL PERIOD 9: DAY 78/15h - DAY 79/23h

During this time period, there are three opportunities to make multiple boundary observations. At approximately Day 78/22h, three satellites are at the magnetopause boundary: IMP-H (Figure 58), Vela 6B (Figure 59), and Vela 5B (Figure 60). Note from Figure 57 that Hawkeye 1 encounters the magnetopause boundary at Day 78/19h. At approximately Day 79/11h, Vela 5B (Figure 62) encounters the bow shock, and Hawkeye 1 (Figure 61) makes a close approach to this boundary. Note from Figure 56 that Hawkeye 1 appears to be in the interplanetary medium at this time because of the rotation effect referred to earlier. At approximately Day 79/17h, Vela 6A (Figure 63) and IMP-H (Figure 64) encounter the bow shock. Note in Figure 56 that IMP-J is in the interplanetary medium throughout this Special Period.

IV.10 SPECIAL PERIOD 10: DAY 175/16h - DAY 178/17h

Three conjunctions occur in this Special Period. At approximately Day 175/23h, IMP-H (Figure 67) and Vela 6B (Figure 68) are at the bow shock, and IMP-J (Figure 69) is at the magnetopause. At approximately Day 176/8h, Vela 5B (Figure 70) and Hawkeye 1 (Figure 71) are at the magnetopause. At approximately Day 177/13h, Vela 6B (Figure 72) is at the bow shock, and IMP-J (Figure 73) is at the magnetopause. Further, from Figure 66, it is evident that there are three satellites in the neutral sheet over the time period Day 177/11.5h-13h and one Vela satellite and IMP-H in the sheet over the time interval Day 177/9.5h-15h. Note from

Figures 74 and 66 that Hawkeye 1 makes a close approach to the bow shock while IMP-H is in the sheet. Neutral sheet plots are shown in Figure 75 through 78. From Figure 130, note that SMS 2 passes through local midnight during the period in which the satellites are in the neutral sheet.

IV.11 SPECIAL PERIOD 11: DAY 189/8h - DAY 190/20h

In Figure 80, it can be seen that, although the two satellites are not in the neutral sheet simultaneously, there is good coverage of this region from the IMP-J and IMP-H satellites over the time period Day 189/14h - Day 190/8h. Neutral sheet plots are shown in Figures 86 through 88. Note that the two satellites are well separated in Y_{GSM} and that Vela 5B (Figure 81) encounters the bow shock during this time. Also, in Figure 130, it can be seen that all five synchronous satellites pass through local midnight during this time period. At approximately Day 190/0h, as IMP-J leaves the neutral sheet, Vela 6A (Figure 82) encounters the bow shock, and Hawkeye 1 (Figure 83) crosses the magnetopause. At approximately Day 190/10h, Vela 5B (Figure 84) encounters the magnetopause boundary shortly after IMP-H leaves the neutral sheet. At approximately Day 190/13h, IMP-J (Figure 85) and Vela 6A (Figure 82) encounter the magnetopause boundary.

IV.12 SPECIAL PERIOD 12: DAY 191/21h - DAY 192/10h

Only boundary plots are shown for this time period, and it may be seen that IMP-H (Figure 89) and Hawkeye 1 (Figure 90) encounter the magnetopause at approximately Day 192/3h. Note in Table 3 that IMP-J is in the interplanetary medium.

IV.13 SPECIAL PERIOD 13: DAY 204/6h - DAY 204/20h

Only boundary plots are shown for this time period, and it may be seen that IMP-H (Figure 91), Vela 5B (Figure 92), and Vela 6A (Figure 93) encounter the magnetopause at approximately Day 204/13h. Note in Table 3 that IMP-J is in the interplanetary medium.

IV.14 SPECIAL PERIOD 14: DAY 213/23h - DAY 216/4h

Three conjunctions occur during this Special Period. At approximately Day 214/6h, Hawkeye 1 (Figure 96) approaches the bow shock, and IMP-H (Figure 97) encounters the magnetopause. Note in Figure 94 that Hawkeye 1 is not in the interplanetary medium, and the apparent location is caused by the rotation discussed earlier. From Figure 95, it is evident that two satellites are in the neutral sheet over the time interval Day 214/10h - Day 214/18.5h. Neutral sheet plots are given in Figures 101 through 104. From Figure 130, it can be seen that the synchronous satellites, SMS 1, SMS 2, and ATS 5, pass through local midnight toward the end of this period. At approximately Day 215/22h, three satellites encounter the magnetopause: IMP-J (Figure 98), Vela 5B (Figure 99), and Vela 6A (Figure 100).

IV.15 SPECIAL PERIOD 15: DAY 331/11h - DAY 331/24h

Only boundary plots are shown for this time period, and it may be seen that IMP-H (Figure 105) and Hawkeye 1 (Figure 106) encounter the magnetopause boundary at approximately Day 331/17h. Note in Table 3 that IMP-J is in the interplanetary medium during this period.

IV.16 SPECIAL PERIOD 16: DAY 338/7h - DAY 338/23h

Only boundary plots are shown in this time period. At approximately Day 338/14h, three satellites encounter the magnetopause: IMP-J (Figure 107), Vela 6A (Figure 109), and Vela 6B (Figure 110). Shortly afterward, Vela 5B (Figure 108) encounters the magnetopause.

IV.17 SPECIAL PERIOD 17: DAY 341/6h - DAY 343/14h

Three conjunctions occur during this period. At approximately Day 341/13h, Vela 5B (Figure 113) and IMP-H (Figure 114) encounter the magnetopause, and Hawkeye 1 (Figure 115) approaches the bow shock. From Figure 112, it may be seen that three satellites are in the neutral sheet over the time period Day 342/17h-19.5h. Neutral sheet plots are shown in Figures 119 through 121. From Figure 130, it may be seen that ATS 5, SMS 1, and GOES 1 pass through local midnight in this time period. At approximately Day 343/7h, three satellites encounter the magnetopause: Vela 6A (Figure 116), Hawkeye 1 (Figure 117), and Vela 6B (Figure 118). Note from Table 3 that IMP-J is in the interplanetary medium throughout this Special Period.

IV.18 SPECIAL PERIOD 18: DAY 365/1h - DAY 366/14h

Two conjunctions occur during this Special Period. At approximately Day 365/8h, IMP-J (Figure 125) encounters the magnetopause, IMP-H (Figure 126) encounters the bow shock, and Hawkeye 1 (Figure 127) makes a close approach to the bow shock. From Figures 123 and 124, it may be seen that Hawkeye 1 is in, or very close to, the cusp, and at least one Vela is in the neutral sheet over the time period Day 365/22h - Day 366/1.5h. Neutral sheet plots are given in Figures 128 and 129.

V. ROCKET, BALLOON, AND AIRCRAFT ACTIVITY DURING THE SPECIAL PERIODS

With the satellite situation clarified, the next step is the presentation of the rocket, balloon, and aircraft activity for the Special Periods. The main summary of this activity is in the IMS Directory No. 2. Launch dates are indicated by month and year, although many entries contain only the year. The programs of magnetospheric interest for the Special Periods are given in Table 7. The dates found in the directory were updated in some cases where a member of the Steering Committee had first-hand knowledge of a given campaign. The program summary number gives the identification of the program in the IMS File. There are other programs listed for 1976, but without a specific month given for them. These are shown in Table 8, along with two programs scheduled for October 1976.

VI. IMS CALENDARS

The Special IMS Satellite Periods have been added to the International Geophysical Calendar; this appears as Figure 131. The start and stop times of each Period are not shown on the calendar, but this information is available in Table 2.

An IMS Calendar was originated by Drs. Paul Simon and J. P. Legrand in their paper discussing IMS coordination. This provides a graphic display of the various programs. Their calendar for the first 6 months of 1976 has been updated and extended to the end of 1976, and with the Special IMS Satellite Periods added. This is presented in Figure 132. The place where the experiment will be conducted is listed first in the left-hand column; underneath each location are lists of names and the corresponding IMS program summary numbers. Beside each name, extending over the appropriate time period, are the launch windows for each campaign. A code for rockets, balloons, and aircraft is given, and the number of symbols denotes the number of flights planned.

VII. CHARACTERISTICS OF ORBITS AND DATA ACQUISITION PLANS FOR OPERABLE SPACECRAFT OF POSSIBLE USE TO THE IMS IN 1976

Most of the information about the spacecraft that may have some use in the IMS program is given in Tables 9 and 10. These are nearly identical to Tables 1 and 2 in the December 1975 announcement. However, there were some errors in the orbit periods noted in that publication, so the corrected tables are presented here. Those scientific spacecraft which are not scheduled to acquire data throughout 1976, but which should be operable, are Hawkeye 1, ATS 5, ATS 6, AE-C, AE-D, and AE-E. Consequently, any plans for utilizing data from these payloads should be coordinated as soon as possible.

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NOTE ADDED IN PROOF

The USSR has announced the launching of the Prognoz 4 satellite December 22, 1975. The satellite has an inclination of 65°, a perigee height of 634 km, an apogee height of 199000 km, and a period of 5740 min. Prognoz 4 carries instrumentation to measure magnetic field, solar wind particles, and solar electromagnetic radiation.

Table 1. DEFINITIONS OF REGIONS OF SPACE FOR SPECIAL PERIODS

Region	Symbol	Definition
High-Latitude Magnetotail	HT	$X_{GSM} < -10R_E$, $\lvert Z_{GSM} - Z_{sh}\rvert > 6R_E$
Midlatitude Magnetotail	MT	$X_{GSM} < -10R_E$, $6R_E \geq \lvert Z_{GSM} - Z_{sh}\rvert \geq 2R_E$
Neutral Sheet	Sh	$X_{GSM} < -10R_E$, $2R_E > \lvert Z_{GSM} - Z_{sh}\rvert$
Dayside Magnetosphere	DM	Magnetosphere for $X_{GSE} > 0R_E$
Nightside Magnetosphere	NM	Magnetosphere for $0R_E \geq X_{GSE} \geq -10R_E$
Dayside Magnetosheath	DS	Magnetosheath for $X_{GSE} > 0R_E$
Nightside Magnetosheath	NS	Magnetosheath for $0R_E \geq X_{GSE}$
Interplanetary Medium	I	
Dayside Access Region (cusp)	C	80° ≥ Mag. Lat ≥ 75°, 16h ≥ Mag. Local Time ≥ 8h+
Bow Shock Wave	S	Corresponds to 420 km/sec Solar Wind Speed*
Magnetopause	P	Corresponds to 420 km/sec Solar Wind Speed*

GSM: Geocentric Solar Magnetospheric Coordinate System
GSE: Geocentric Solar Ecliptic Coordinate System

+ Heikkila (1971).
* Fairfield's Model (1972).

Table 2. SPECIAL IMS PERIODS FOR 1976 - TIME INTERVALS

No.	Special Period (Day/h)	Special Period (Date/h)	Duration (h)
1	2/16h to 4/16h	Jan. 2/16h to Jan. 4/16h	48
2	13/0h to 13/13h	Jan. 13/0h to Jan. 13/13h	13
3	25/13h to 26/24h	Jan. 25/13h to Jan. 26/24h	35
4	27/23h to 28/13h	Jan. 27/23h to Jan. 28/13h	14
5	39/15h to 40/20h	Feb. 8/15h to Feb. 9/20h	29
6	52/21h to 54/1h	Feb. 21/21h to Feb. 23/1h	28
7	62/7h to 64/2h	Mar. 2/7h to Mar. 4/2h	43
8	66/5h to 67/15h	Mar. 6/5h to Mar. 7/15h	34
9	78/15h to 79/23h	Mar. 18/15h to Mar. 19/23h	32
10	175/16h to 178/17h	Jun. 23/16h to Jun. 26/17h	73
11	189/8h to 190/20h	Jul. 7/8h to Jul. 8/20h	36
12	191/21h to 192/10h	Jul. 9/21h to Jul. 10/10h	13
13	204/6h to 204/20h	Jul. 22/6h to Jul. 22/20h	14
14	213/23h to 216/4h	Jul. 31/23h to Aug. 3/4h	53
15	331/11h to 331/24h	Nov. 26/11h to Nov. 26/24h	13
16	338/7h to 338/23h	Dec. 3/7h to Dec. 3/23h	16
17	341/6h to 343/14h	Dec. 6/6h to Dec. 8/14h	56
18	365/1h to 366/14h	Dec. 30/1h to Dec. 31/14h	37

Table 3. SPECIAL IMS PERIODS FOR 1976 - SATELLITES AND REGIONS

No.	Time (Day/h)	IMP-J	IMP-H	Hawkeye 1	Vela 5B	Vela 6A	Vela 6B
		Satellites					
1	3/2h	NS	MT	**C**	**Sh**	**Sh**	I
	3/20h	NS	NS	DM	**P**	NM	**P**
	4/1h	NS	**S**	**P**	DS	**P**	HT
	4/10h	**S**	I	DS	**S**	DS	HT
2	13/6h	NS	**P**	NS	**P**	NM	NM
3	25/19h	**P**	**P**	DS	MT	NM	I
	26/6h	HT	**Sh**	NS	**Sh**	**Sh**	I
4	28/6h	**P**	**P**	NS	I	I	MT
5	40/1h	**Sh**	HT	DM	**Sh**	**Sh**	I
6	53/4h	**P**	HT	**P**	**S**	**S**	**S**
	53/19h	NS	**P**	DS	NM	**P**	I
7	62/14h	**P**	I	DS	DS	**S**	I
	62/24h	**Sh**	**S**	**P**	**P**	NS	I
	63/2h	**Sh**	NS	**C**	NM	NS	I
8	66/11h	**S**	**P**	DS	I	I	I
	67/7h	I	**S**	**C**	DS	**S**	I
9	78/22h	I	**P**	DS	**P**	NM	**P**
	79/11h	I	NS	**S***	**S**	NS	HT
	79/17h	I	**S**	DS	I	**S**	HT
10	175/23h	**P**	**S**	DS	DS	DS	**S**
	176/8h	HT	NS	**P**	**P**	NS	I
	177/14h	**P**	**Sh**	DS	**Sh**	**Sh**	**S**
11	189/21h	**Sh**	**Sh**	NM	**S**	I	I
	190/0h	MT	MT	**P**	DS	**S**	I
	190/13h	**P**	MT	**S***	NM	**P**	I
12	192/3h	I	**P**	**P**	HT	HT	DS
13	204/13h	I	**P**	NM	**P**	**P**	I

*Denotes close approach.

Table 3. SPECIAL IMS PERIODS FOR 1976 - SATELLITES AND REGIONS (concluded)

		Satellites					
No.	Time (Day/h)	IMP-J	IMP-H	Hawkeye 1	Vela 5B	Vela 6A	Vela 6B
14	214/6h	HT	**P**	**S***	NM	NM	I
	214/14h	**Sh**	HT	DS	**Sh**	**Sh**	I
	215/22h	**P**	HT	NS	**P**	**P**	HT
15	331/17h	I	**P**	**P**	DS	I	I
16	338/14h	**P**	I	NM	**P**	**P**	**P**
17	341/13h	I	**P**	**S***	**P**	NM	I
	342/18h	I	**Sh**	NM	**Sh**	**Sh**	NS
	343/7h	I	HT	**P**	NM	**P**	**P**
18	365/8h	**P**	**S**	**S***	HT	HT	I
	366/0h	NS	NS	**C**	**Sh**	**Sh**	I

*Denotes close approach.

Table 4. SPECIAL IMS PERIODS FOR 1976 - CONJUNCTIONS

Multiple Shock Crossings	Multiple Magnetopause Crossings		Multiple Neutral Sheet Passes	Neutral Sheet and Cusp Passes
4/10h	3/20h	4/1h	26/6h	3/2h
53/4h	13/6h	25/19h	40/1h	63/2h
67/7h	28/6h	53/4h	177/14h	366/7h
79/11h	53/19h	62/24h	190/1h	
79/17h	78/22h	176/8h	214/14h	
175/23h	190/13h	192/3h	342/18h	
365/8h	204/13h	215/22h		
	331/17h	338/14h		
	341/13h	343/7h		

Time shown as Day/Hour.

Table 5. HIGH-ALTITUDE SATELLITE EXPERIMENT PACKAGES

Satellite	PI	Measurement	Satellite	PI	Measurement
Hawkeye 1	Frank	Low-Energy Particles	IMP-H, -J	Frank	Low-Energy Particles
Hawkeye 1	Gurnett*	ELF/VLF Receivers	IMP-H, -J	Gloeckler	Ions and Electrons
Hawkeye 1	Van Allen	Magnetometer	IMP-H, -J	Krimigis	Charged Particles
Vela 5B	Bame	Solar Wind Experiment	IMP-H, -J	McDonald	Solar Particles
Vela 5B, 6A, 6B	Bame	Neutron Detector	IMP-H	Ogilvie*	Solar Wind Ions
Vela 5B	Conner	Cosmic X Rays	IMP-H	Scarf*	Plasma Wave Experiment
Vela 5B, 6A, 6B	Singer	Solar Particle Telescope	IMP-H, -J	Simpson	Solar Flare Isotopes
Vela 5B, 6A, 6B	Singer	Electron Detectors	IMP-H, -J	Stone	Electrons/Hydrogen/Helium
Vela 6A	Chambers	Solar X Ray	IMP-H, -J	Williams*	Energetic Particles
Vela 6A	Klebesadel	Gamma Ray	IMP-J	Aggson	Electrostatic Fields
IMP-H, -J	Bame	Solar Plasma	IMP-J	Gurnett*	Electrostatic Waves
IMP-H, -J	Bridge	Solar Plasma	IMP-J	Ness*	Magnetometer
IMP-H	Cline	Solar, Mag. Electrons			

*These Principal Investigators (PI) have IMS Program Summary Numbers in IMS Directory No. 2.

ALL ABOVE EXPERIMENTS ARE OPERATING NORMALLY WITH THE FOLLOWING EXCEPTIONS:

Vela 5B - Bame Solar Wind-ESA to measure solar wind electrons, protons, & alphas has failed.
IMP-H - Simpson; priority event selector inoperative.
IMP-H - Krimigis; 4 GM tubes inoperative.
IMP-H - Gloeckler; ULET inoperative.
IMP-H - Bridge; RFI background.
IMP-J - Ness; operating only in 36 gamma full-scale mode (0.3 gamma resolution).
IMP-J - Gurnett; no x impedance measurement.

Table 6. LOW-ALTITUDE, SYNCHRONOUS, AND OTHER SATELLITE EXPERIMENT PACKAGES

AE-C		
	Barth	Ultraviolet Nitric Oxide Experiment
	Brace	Electron Temperature and Concentration
	Brinton	Bennett Ion-Mass Spectrometer
	Champion	Atmospheric Drag
	Doering	Photoelectron Spectrometer
	Hanson	Ion Temperature
	Hays	Airglow Photometer
	Hoffman	Magnetic Ion-Mass Spectrometer
	Hoffman	Low-Energy Electrons
	Nier	Open Source Neutral Mass Spectrometer
	Rice	Cold-Cathode Ion Gauge
	Spencer	Neutral Gas Temperature and Concentration[1]
AE-D		
	Barth	Ultraviolet Nitric Oxide Experiment
	Brace	Electron Temperature and Concentration
	Champion	Atmospheric Drag
	Doering	Photoelectron Spectrometer
	Hanson	Ion Temperature
	Hays	Airglow Photometer
	Hoffman	Ion Composition and Concentration
	Hoffman	Low-Energy Electrons
	Nier	Open Source Neutral Mass Spectrometer
	Pelz	Closed Source Neutral Mass Spectrometer
	Rice	Cold-Cathode Ion Gauge
	Spencer	Neutral Gas Temperature and Concentration
AE-E		
	Brace	Electron Temperature and Concentration
	Brinton	Ion Composition and Concentration
	Champion	Atmospheric Drag
	Doering	Photoelectron Spectrometer
	Hanson	Ion Temperature
	Hays	Airglow Photometer
	Nier	Open Source Neutral Mass Spectrometer
	Pelz	Closed Source Neutral Mass Spectrometer
	Rice	Cold-Cathode Ion Gauge
	Spencer	Neutral Gas Temperature and Concentration
ATS 5		
	Darosa	Radio Beacon
	McIlwain	Omnidirectional High-Energy Particle Detector
	McIlwain	Bidirectional, Low-Energy Particle Detector[2]
	Mozer	Tridirectional, Medium-Energy Particle Detector
	Sugiura	Magnetic Field Monitor[3]
ATS 6		
	Coleman, Jr.	Magnetometer[4]
	Davies	Radio Beacon
	Fritz	Low-Energy Protons
	Masley	Solar Cosmic Rays and Geomagnetically Trapped Radiation
	McIlwain	Auroral Particles Experiment[5]
	Paulikas	Omnidirectional Spectrometer
	Winckler	Particle Acceleration Mechanisms and Dynamics of the Outer Trapping Region[6]

See footnotes at end of table.

Table 6. LOW-ALTITUDE, SYNCHRONOUS, AND OTHER SATELLITE EXPERIMENT PACKAGES (concluded)

ISIS 2[7]	
Anger	3914-A to 5577-A Photometer
Barrington	VLF Receiver
Brace	Cylindrical Electrostatic Probe
Calvert	Fixed Frequency Sounder
Forsyth	Radio Beacon[8]
Hartz	Cosmic Radio Noise
Heikkila	Soft-Particle Spectrometer[9]
Hoffman	Ion-Mass Spectrometer
Maier	Retarding Potential Analyzer
McDiarmid	Energetic Particle Detectors[10]
Shepherd	6300-A Photometer
Whitteker	Sweep Frequency Sounder
ISS	
Fugono	Positive Ion-Mass Spectrometer
Matuura	Sweep Frequency Topside Ionospheric Sounder
Miyazaki	Retarding Potential Probe
Muranago	Radio Noise Near 2.5, 5, 10, and 25 MHz
SOLRAD 11A and 11B[11]	
Blake	Solar Protons
Blake	Omnidirectional Protons
Blake	Antisolar Protons
Byram	Stellar/Auroral X Rays
Kelley	Proton, Alpha Telescope
Kelley	Low-Energy Proton Spectrometer
Lazarus	Faraday Cup
Vampola	Solar Flare Electrons
SMS-1	
Williams	Energetic Particle Monitor
Williams	Solar X-Ray Monitor
Williams	Magnetic Field Monitor
SMS-2	
Williams	Energetic Particle Monitor
Williams	Solar X-Ray Monitor
Williams	Magnetic Field Monitor
GOES 1	
Williams	Energetic Particle Monitor
Williams	Solar X-Ray Monitor
Williams	Magnetic Field Monitor

1 Filament problems.
2 Electron detectors have failed.
3 No further data processing by experimenter.
4 Y-axis sensor not operating.
5 One dectector inoperable. Two detectors have 1/2 of energy range available. Other two detectors are nominal.
6 One or more detectors are inoperable.
7 Real-time data only; tape recorder is out.
8 Interference with other S/C operations prevents measurement of electron content.
9 Measures electrons or protons exclusively.
10 20-kev detector not functioning properly.
11 Solar EUV and X-ray experiments not listed here.

Table 7. ROCKET, BALLOON, AND AIRCRAFT PROGRAMS PLANNED FOR MONTHS CONTAINING SPECIAL IMS SATELLITE PERIODS DURING 1976

Program Summary Number	Name	Measurement	Remarks
28	Riedler	Rocket, Balloon - Protons, Cold Plasma, Electric Field	March, April; on Porcupine
37	Storey	Rocket - Ion-Mass Spectrometer	March, April; on Porcupine
100	McEwen	Rocket - Auroral Measurements	February
159	Chanin	Rocket - Sodium Release	February, March
164	Davis	Rocket, Aircraft - Auroral, Electric Field	March
193	Hirao	Rocket - Ionospheric Measurements	January
224	Kuhn	Aircraft - Airglow Photometer	March
303	Stoker	Balloon - X Rays	January, February
305	Studemann	Rocket - Energetic Particles, Hot Plasma	March, April; on Porcupine
308	Theile	Rocket - Ionospheric Measurements	March, April; on Porcupine
328	Tinsley	Rocket - EUV Spectrometer	February
356	Sheldon	Balloon - X Rays, Electric Field	March
400	Berning	Rocket, Balloon, Aircraft - Auroral, Ionospheric Measurements	February
450	Johnstone	Rocket - Intermediate and Hot Plasma	January
474	Rees	Rocket - Auroral Measurements	January, February
522	Truttse	Aircraft - Airglow Photometer	January, February
539	Barat	Rocket - Electric Field	March
69	Tanskanen	Balloon - X Rays, Electric Fields	July
311	Ungstrup	Balloon, Rocket - Electric Fields, Charged Particles	May, July
104	Niles	Balloon - Ion-Mass Spectrometer	April, May, September, December
129	Rawer	Rocket - Ret. Pot. Analyzer, Electric Field	October-December
172	Fälthammar	Rocket - Electric Fields	October-December
308	Theile	Rocket - Ionospheric Measurements	October-December
400	Berning	Rocket, Balloon, Aircraft - Auroral, Ionospheric Measurements	November
450	Johnstone	Rocket - Intermediate and Hot Plasma	November
474	Rees	Rocket - Auroral Measurements	October-December

Table 8. ROCKET, BALLOON, AND AIRCRAFT PROGRAMS DURING 1976 FOR MONTHS NOT CONTAINING SPECIAL IMS SATELLITE PERIODS OR WITH NO MONTH SPECIFIED IN THE IMS DIRECTORY

Program Summary Number	Name	Measurement	Remarks
41	Thrane	Rocket, Balloon-ELF/VLF, Cold Plasma	
85	Dickinson	Rocket - Neutral Atmosphere	
89	Derblom	Rocket, Balloon - Auroral Photometer, Electric Field	
90	Horton	Rocket - Ion-Mass Spectrometer	
99	MacLeod	Rocket - Ionospheric, Atmospheric Measurements	
133	Bain	Rocket - Airglow Photometer, UV	
145	Wrenn	Rocket - Electrostatic Analyzer	October
149	Bullough	Rocket - ELF/VLF Measurements	
170	Evans	Rocket - Ionospheric Measurements	
219	Liszka	Rocket - Intermediate Energy Plasma	
221	Kotadia	Rocket - Langmuir Probe	
263	Olesen	Rocket - Ionospheric Measurements	
269	Parks	Balloon - X Rays	
270	Parthasarathy	Rocket - Langmuir Probe	
287	Yoshino	Rocket, Balloon - VLF Receivers	
288	Rycroft	Rocket - ELF/VLF Measurements	
313	Unwin	Balloon - X Rays, Electric Field	
332	De Mendonca	Balloon - Atmospheric Measurements	
349	Rao	Rocket, Balloon - Ionospheric Measurements, X Rays	
381	McNamara	Rocket - Ionospheric Measurements	
429	Tohmatsu	Rocket - Ionospheric Measurements	
443	Hultquist	Rocket - Ionospheric Measurements	October
456	Smilauer	Rocket - Langmuir Probe, Ion-Mass Spectrometer	
457	Gledhill	Aircraft - Ionospheric Measurements	
531	Lazutin	Balloon - Ionospheric Measurements	

Updated to 12/17/76
Most Orbits Epoch 10/75

Table 9. IMS AND OTHER USEFUL SCIENTIFIC SPACECRAFT

Spacecraft	Launch Date	Inc. (deg)	Perigee Alt. (km)	Apogee Alt. (km)	Period (min)	Remarks	Sci. Type
OSO 8	06/22/75	32.9	544.1	559.4	95.6	Solar pointed & wheel experiments. Operations committed through 1Q/76, planned through 1Q/77.	SOLAR
D2-B	09/27/75	37.2	503.4	715.5	96.8	Some geocoronal experiments. 8 mo. lifetime.	
SOLRAD 11A	03/ /76	0.	127622.	127622.	8140.	Several energetic particle experiments $R= 21\ R_E$.	
SOLRAD 11B	03/ /76	0.	127622.	127622.	8140.	Same payload as SOLRAD 11A. Operations committed through 3Q/78. Real-time data through ERL, Boulder.	
VELA 5B	05/23/69	43.0	107602.6	115193.0	6704.2	$T= 4.6d$; $R= 17.8 - 19.0\ R_E$. Velas planned to operate through 1977, mainly in Neutral Sheet.	MAGNETOSPHERIC FIELDS & PARTICLES
VELA 6A	04/08/70	41.1	110420.2	112332.1	6702.4	No solar wind measurement operating on 6A or 6B. $T= 4.6d$; $R= 18.3 - 18.7\ R_E$.	
VELA 6B	04/08/70	40.5	110380.7	112205.9	6695.2	$T= 4.6d$; $R= 18.3 - 18.6\ R_E$.	
IMP-H	09/23/72	21.9	199498.5	232820.3	17412.6	$T= 12.1d$; $R= 32.3 - 37.5\ R_E$ IMP operations committed through 7/76, planned through 3Q/78.	
IMP-J	10/26/73	20.3	198585.5	232987.4	17368.8	$T= 12.1d$; $R= 32.1 - 37.5\ R_E$.	
HAWKEYE 1	06/03/74	88.9	4028.5	123388.7	3077.5	Only highly eccentric polar spacecraft during IMS; reenters Feb-May 1978. No data acquisition scheduled after 6/30/76.	
SESP 74-2	2Q/ /76	90.	200.	8000.	177.9		

Table 9. IMS AND OTHER USEFUL SCIENTIFIC SPACECRAFT (concluded)

Spacecraft	Launch Date	Inc. (deg)	Perigee Alt. (km)	Apogee Alt. (km)	Period (min)	Remarks	Sci. Type
ISIS 2	04/01/71	88.2	1355.9	1422.8	113.5	Many TM stations around world. Canada. NASA committed 2Q/76, then standby.	ATMOSPHERIC & IONOSPHERIC
AE-C	12/16/73	68.0	301.7	310.3	90.6	Limited data acquisition in 1976. Standby.	
INTASAT	11/15/74	101.7	1440.9	1457.4	114.9	Beacon; will turn off prior to Jan. 1, 1977. Spain.	
SRATS	02/24/75	31.6	255.0	3136.0	120.3	Some solar experiments. Japan.	
ARIABAT	04/19/75	50.7	568.0	611.0	96.5	India.	
D5-B	05/25/75	30.0	270.1	1238.7	99.9	Microaccelerometer. France. Operations planned through 4Q/75.	
AE-D	10/06/75	90.1	154.7	3816.2	126.9	Orbit maneuvers to change perigee; final state-circular like AE-C. Operations committed through 3Q/76.	
AE-E	11/19/75	19.7	156.8	3025.5	118.1	Similar maneuvers to AE-D. Same operations as AE-D.	
SESP 73-6	12/ /75	90.	230.	900.	96.0		
ISS	02/ /76	70.	1000.	1000.	105.1	First dedicated IMS S/C. Japan.	

Table 10. APPLICATIONS SPACECRAFT WITH ENVIRONMENT EXPERIMENTS USEFUL TO IMS

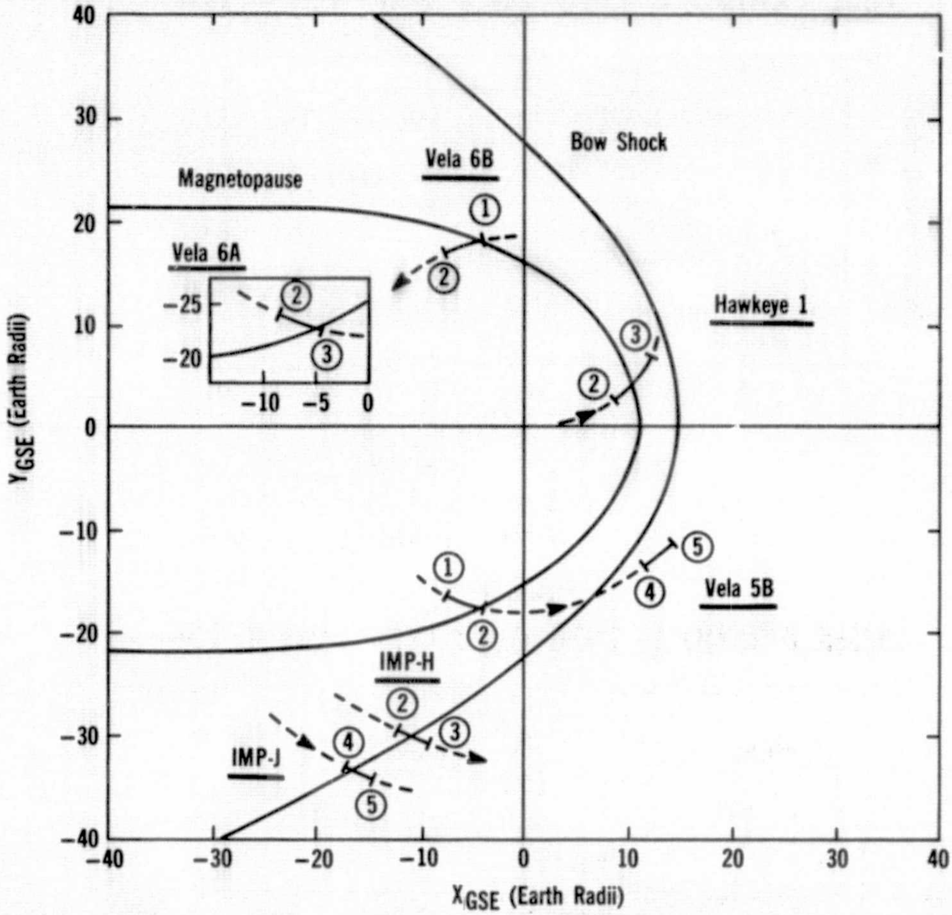
Spacecraft	Launch Date	Inc. (deg)	Perigee Alt. (km)	Apogee Alt. (km)	Period (min)	Remarks	Appl. Type
ATS 5	08/12/69	2.8	35725.4	35848.6	1436.1	Fields & Particles experiments; turned on for special operations only. 105°W Long. 0700 UT = Local Midnight.	COMMUNI-CATIONS
ATS 6	05/30/74	0.6	35775.9	35800.5	1436.2	Fields & Particles experiments; special operations after 7/76. 35°E Long. until 7/76. 2140 UT = Local Midnight.	
TRIAD 1	09/02/72	90.1	749.5	832.1	100.6	Magnetometer; data through 1976.	NAVI-GA-TION
NTS 2	09/ /76	63.	20183.	20183.	718.0	Magnetometer.	
DMSP	When nec.	90.	833.	833.	101.6	Auroral photos & precip. part. made available. Always 2 in orb. Dawn-dusk & noon-midnight.	USAF OPER S/Cs
DSP	/ /76	0.	35700.	35700.	1436.2	Energetic Particles experiments.	

Table 10. APPLICATIONS SPACECRAFT WITH ENVIRONMENT EXPERIMENTS USEFUL TO IMS (concluded)

Spacecraft	Launch Date	Inc. (deg)	Perigee Alt. (km)	Apogee Alt. (km)	Period (min)	Remarks	Appl. Type
NOAA 3	11/06/73	102.0	1500.5	1508.8	116.1	Solar proton monitor.	METEOROLOGICAL
NOAA 4	11/15/74	101.7	1444.3	1457.3	114.9	Solar proton monitor.	
SMS 1	05/17/74	1.8	35776.1	35793.5	1436.0	Particles, B field & X-ray monitor; 105°W Long. Put in standby by 1/76.	
SMS 2	02/06/75	0.6	35766.1	35806.4	1436.1	Same monitor as SMS 1; 135°W Long. 0900 UT = Local Midnight.	
GOES 1	10/16/75	1.0	35769.8	35796.1	1435.9	Same monitor as SMS 1; 75°W Long. Operational by 1/8/76. 0500 UT = Local Midnight.	
ITOS-E2	02/ /76	103.0	1448.0	1453.0	114.9	Solar proton monitor. ITOS becomes NOAA after launch.	
ITOS-H	10/ /76	103.	1448.	1453.	114.9	Solar proton monitor.	
GOES-B	12/ /76	0.	35700.	35700.	1436.2	Same monitor as SMS 1.	

Figure 1

TIME PERIOD 1: 1976 Day 2/22h - Day 4/12h



Code	Time	Vela 5B	Vela 6A	IMP-H	IMP-J	Hawkeye 1	Vela 6B
1	3/18h	NM	NM	NS	NS	DM	NS
2	3/22h	NS	NM	NS	NS	DM	NM
3	4/2h	DS	P	I	NS	P	HT
4	4/9h	DS	DS	I	NS	DS	HT
5	4/12h	I	DS	I	I	DS	MT

Bow Shock Crossings

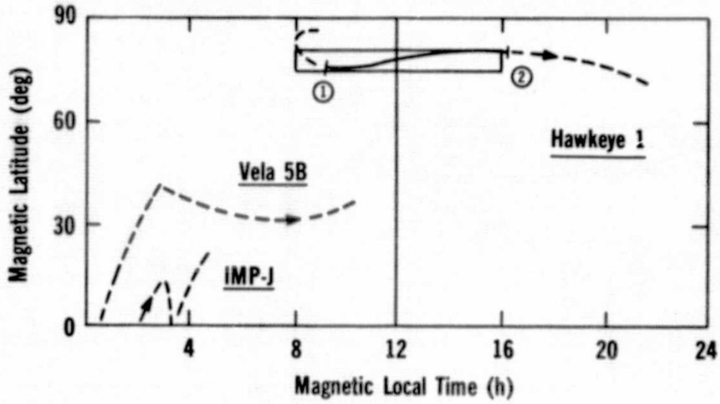
Time	Sat.	Direct.	Lat. (deg)
3/24h	IMP-H	Out	21.2
4/9.5h	Vela 5B	Out	53.2
4/10h	IMP-J	Out	7.6

Magnetopause Crossings

Time	Sat.	Direct.	Lat. (deg)
3/19h	Vela 6B	In	−52.0
3/21.5h	Vela 5B	Out	43.6
4/2h	Hawkeye 1	Out	69.6
4/2h	Vela 6A	Out	41.7

Figure 2

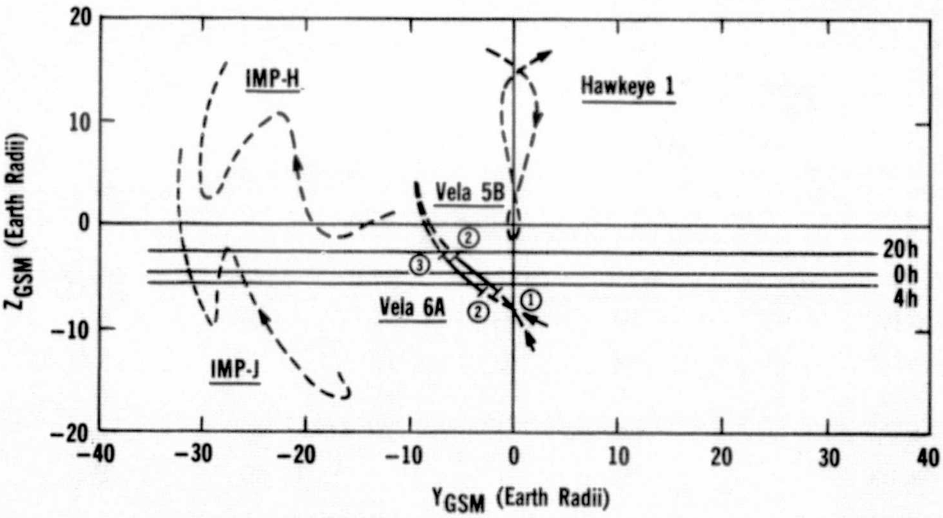
TIME PERIOD 1: 1976 Day 2/22h - Day 4/12h



Code	Time	Alt (E.R.)
1	3/1h	17.5
2	3/7.5h	14.1

Figure 3

TIME PERIOD 1: 1976 Day 2/22h - Day 4/12h



Code	Time	Vela 5B Alt. (E.R.)	Vela 6A Alt. (E.R.)
1	2/22h	17.2	17.4
2	3/2h	17.1	17.4
3	3/5.5h	17.0	17.3

Figure 4. Time Period 1

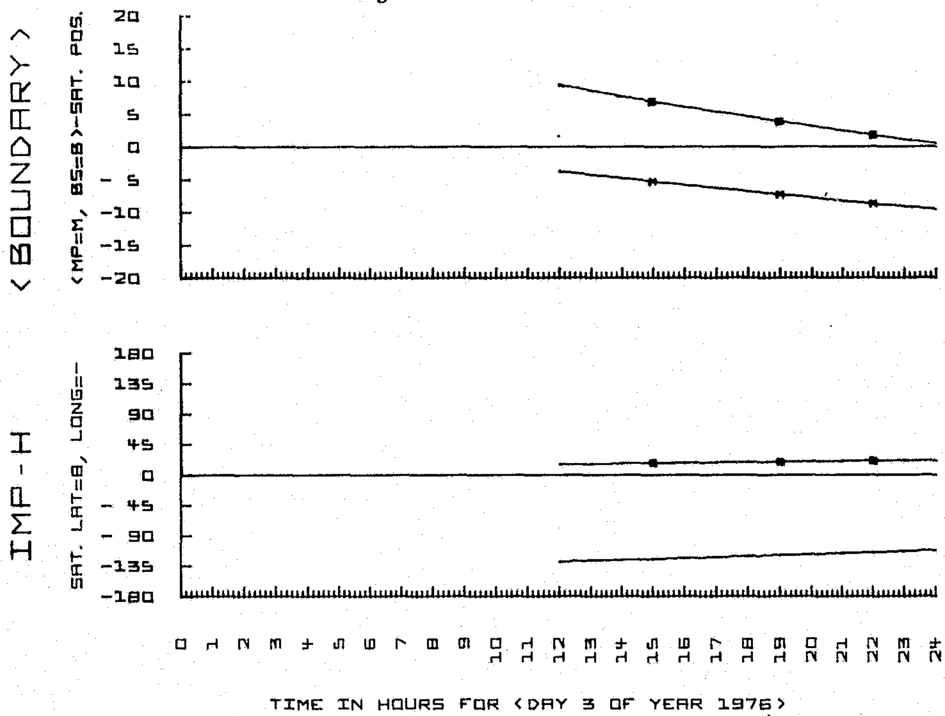


Figure 5. Time Period 1

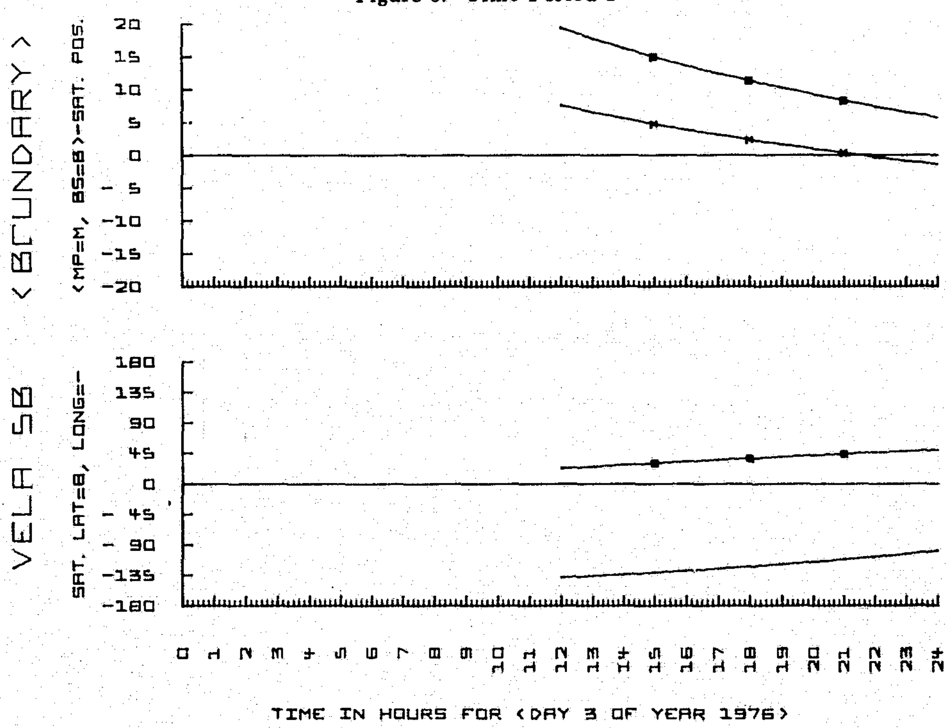


Figure 6. Time Period 1

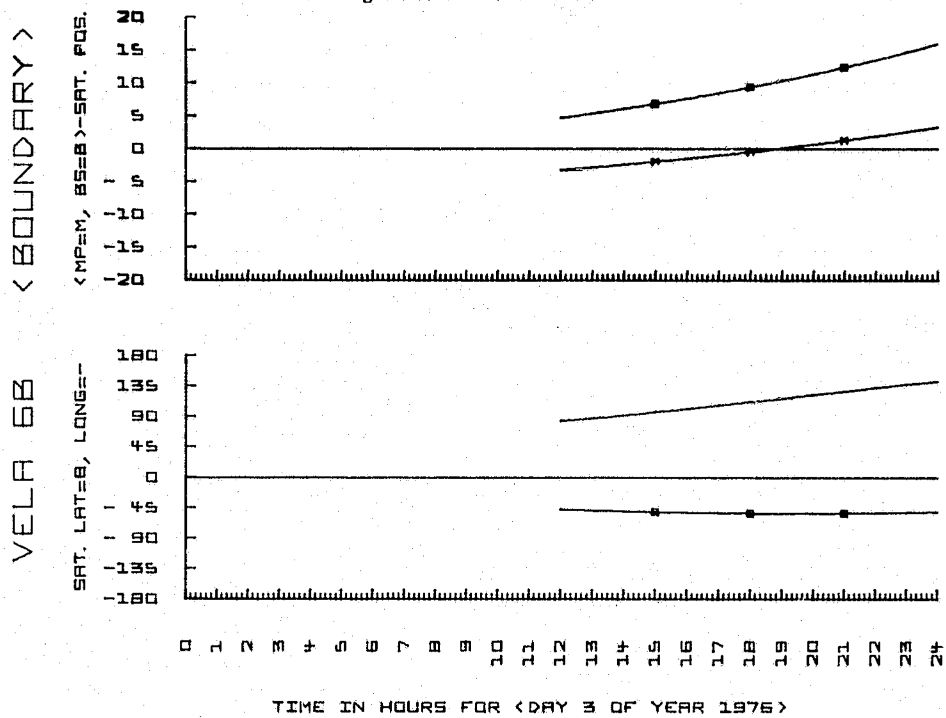


Figure 7. Time Period 1

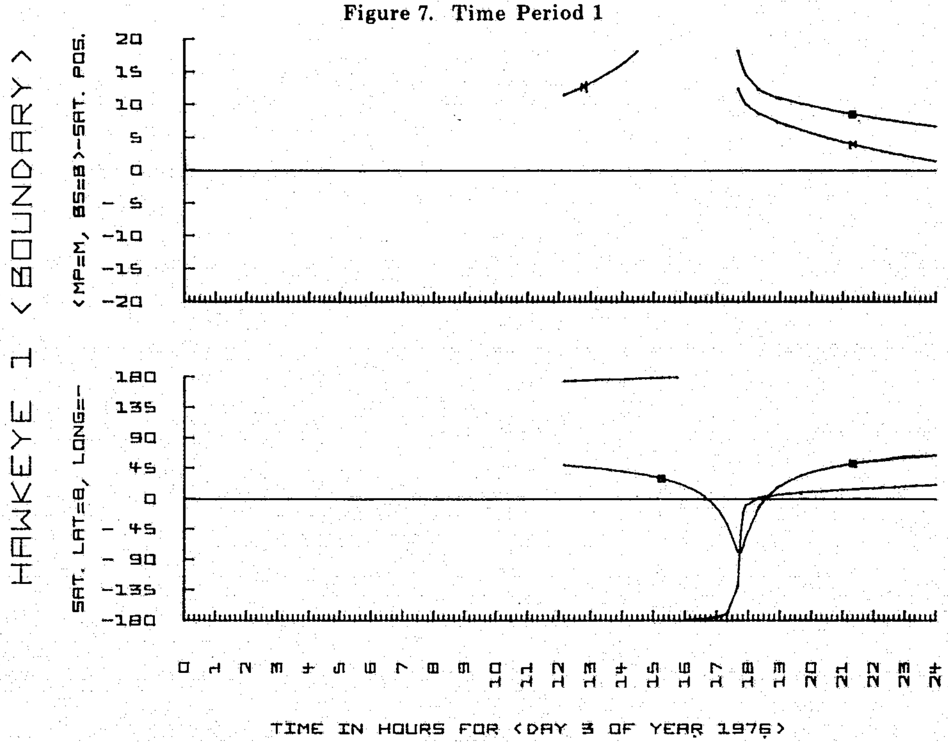


Figure 8. Time Period 1

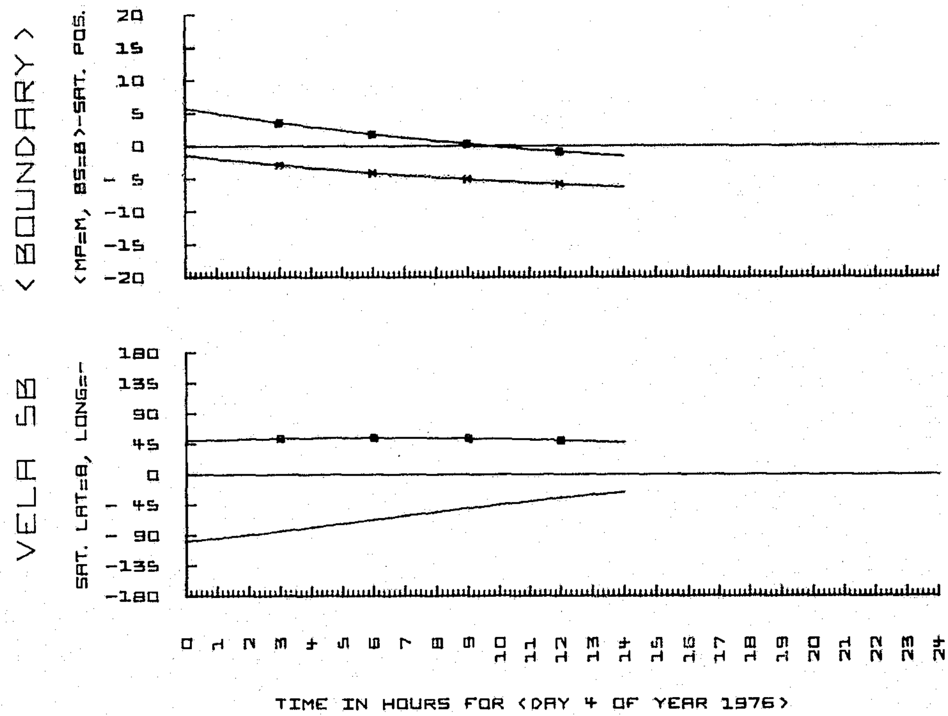


Figure 9. Time Period 1

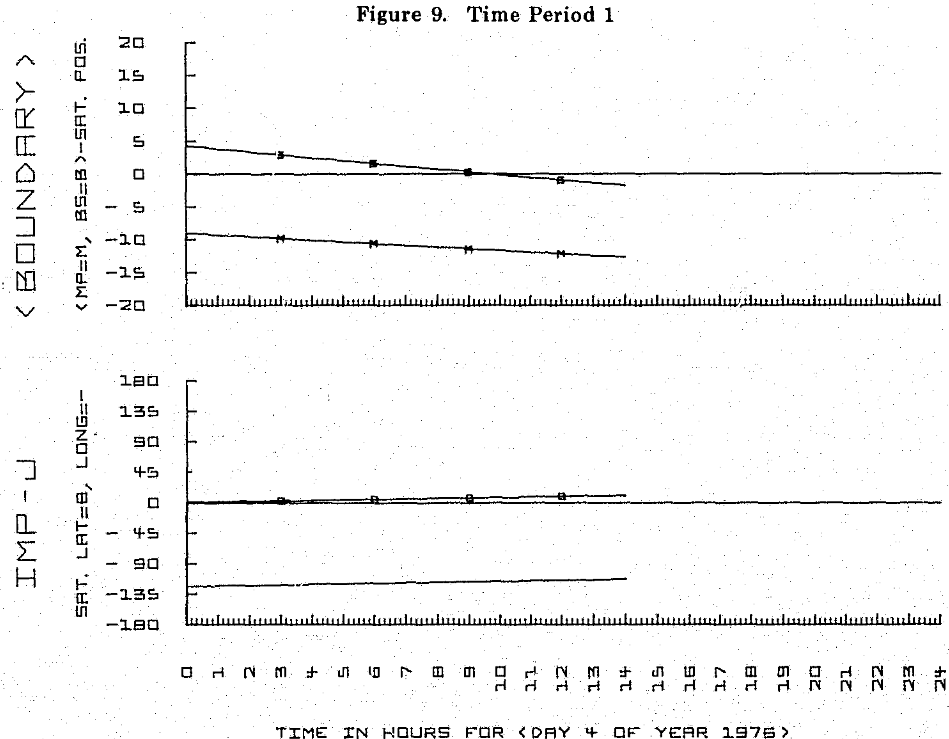


Figure 10. Time Period 1

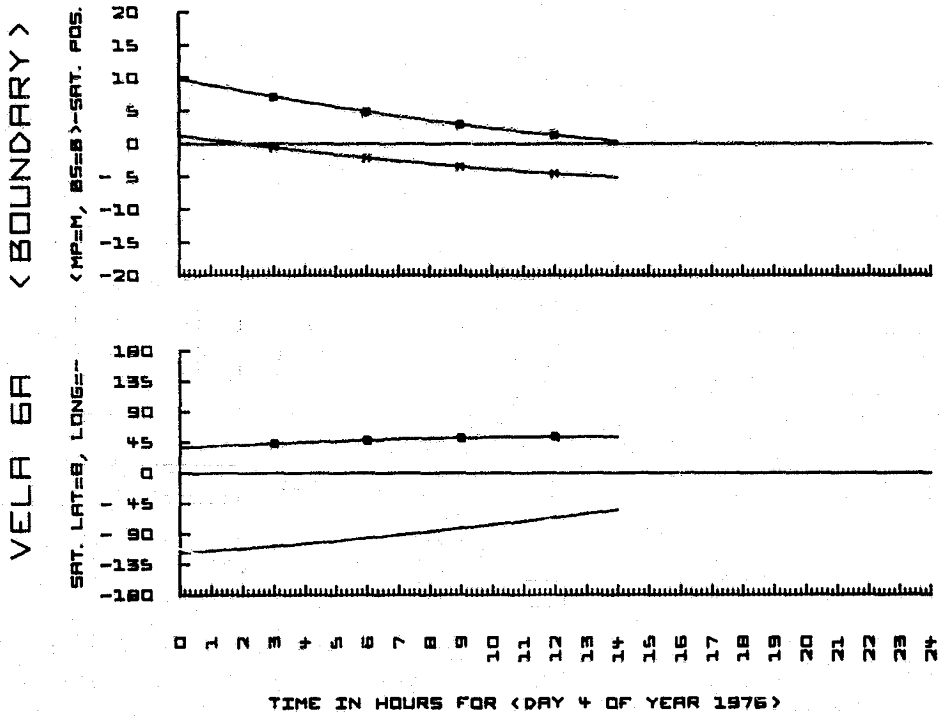


Figure 11. Time Period 1

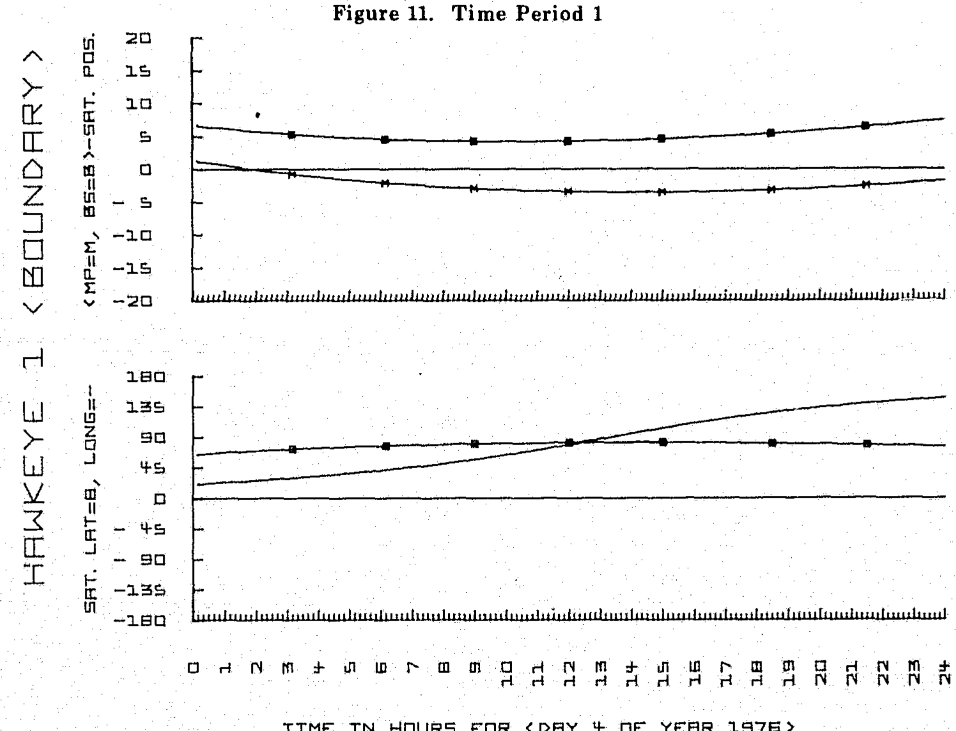


Figure 12. Time Period 1

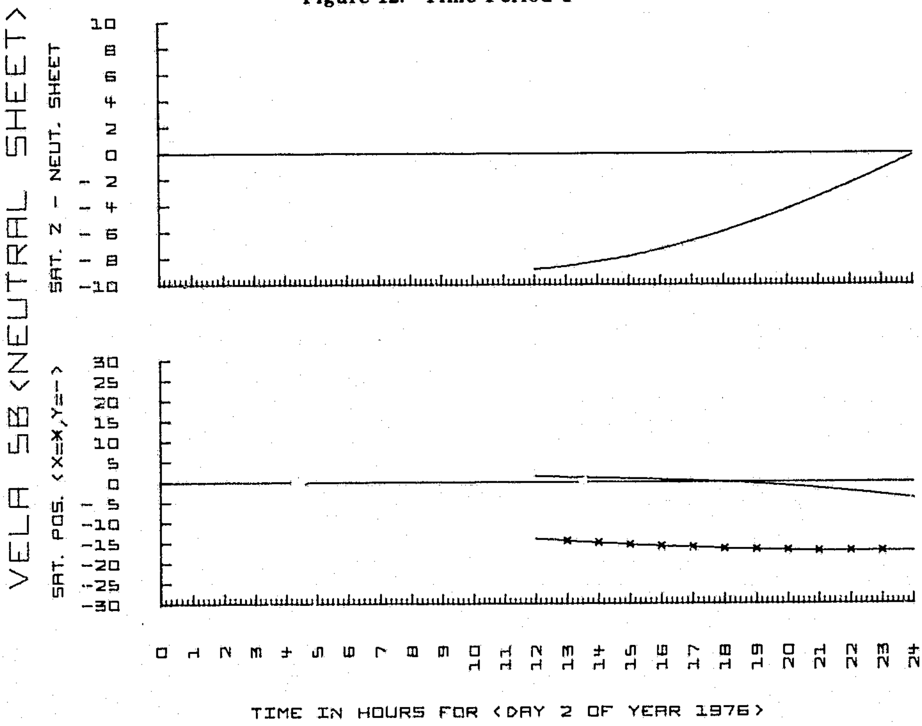


Figure 13. Time Period 1

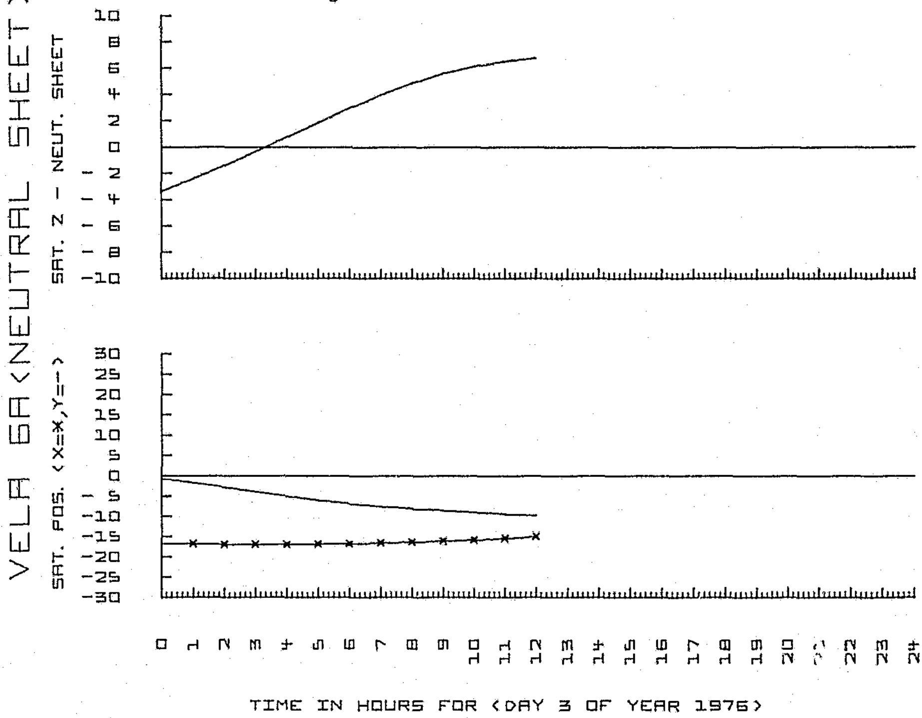


Figure 14. Time Period 1

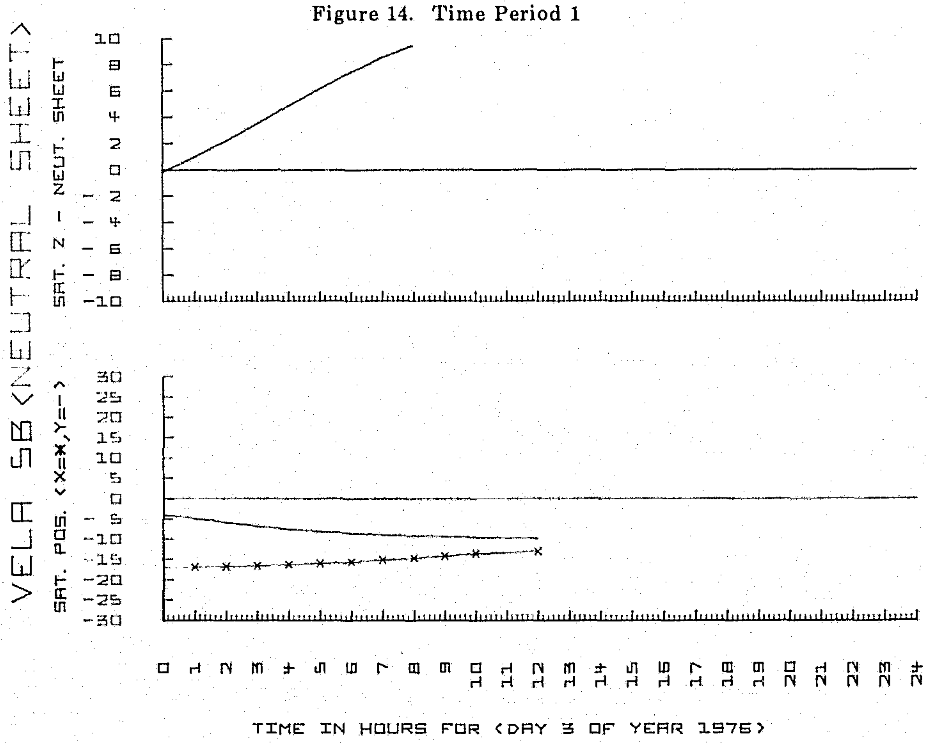


Figure 15. Time Period 2: 1976 Day 13/6h-Day 13/7h

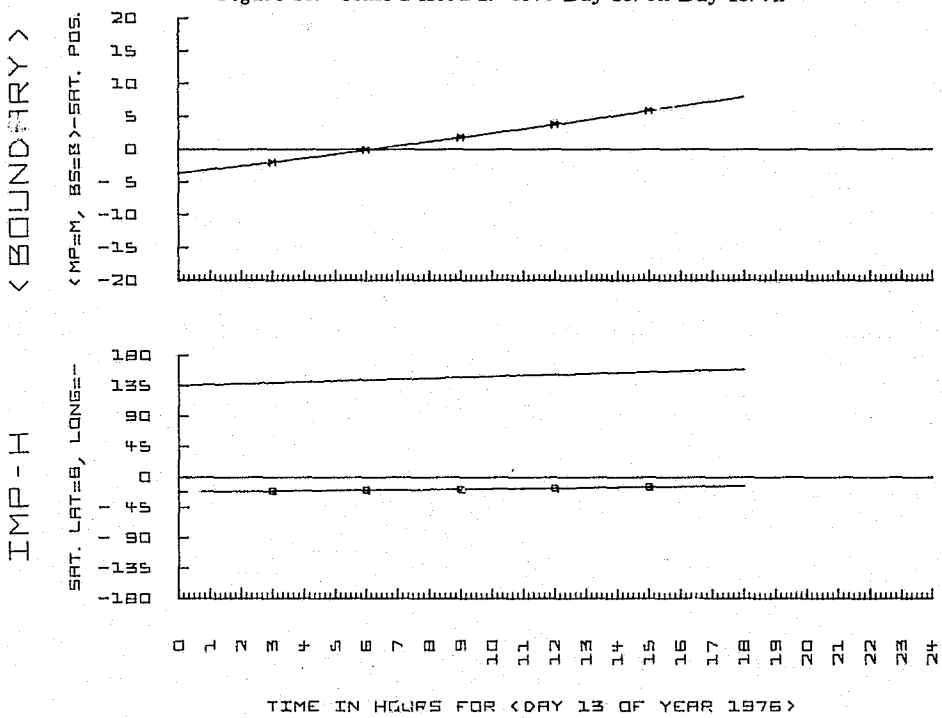


Figure 16. Time Period 2: 1976 Day 13/6h-Day 13/7h

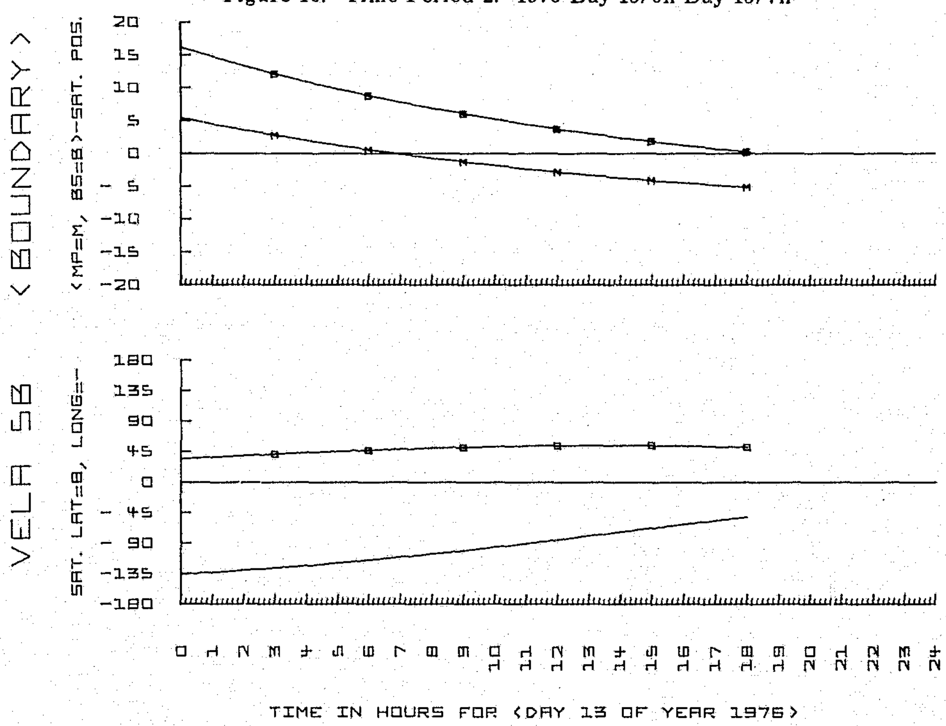
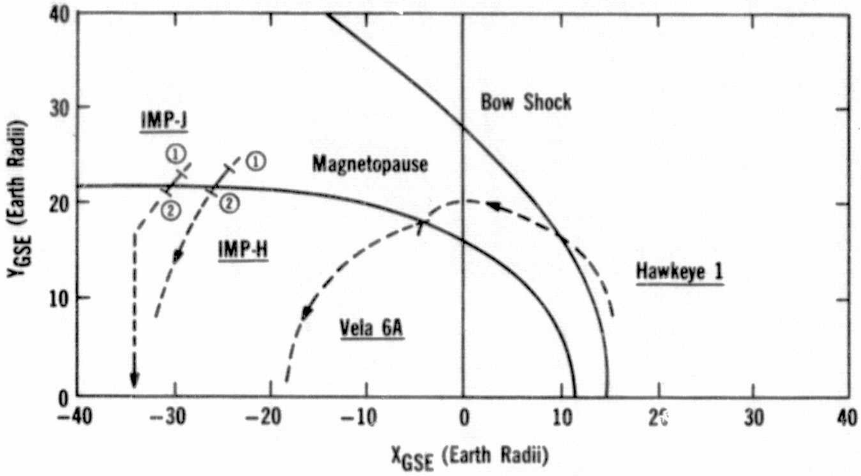


Figure 17

TIME PERIOD 3: 1976 Day 25/16h - Day 26/18h



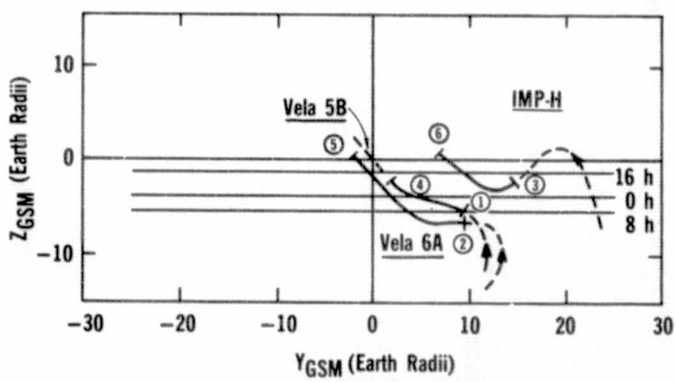
Code	Time	Vela 5B	Vela 6A	IMP-H	IMP-J	Hawkeye 1
1	25/16h	HT	NM	NS	NS	DS
2	25/20h	MT	HT	MT	HT	DS

Magnetopause Crossing

Time	Sat.	Direct.	Lat. (deg)
25/19h	IMP-J	In	−33.1
25/19.5h	IMP-H	In	−14.6

Figure 18

TIME PERIOD 3: 1976 Day 25/16h – Day 26/18h



Code	Time	Vela 6A Alt. (E.R.)	Vela 5B Alt. (E.R.)	IMP-H Alt. (E.R.)
1	25/23h	17.5	17.4	32.5
2	26/3h	17.4	17.2	32.3
3	26/6h	17.4	17.2	32.2
4	26/7h	17.4	17.1	32.2
5	26/16h	17.3	16.9	32.0
6	26/17.5h	17.3	16.9	32.0

Figure 19. Time Period 3

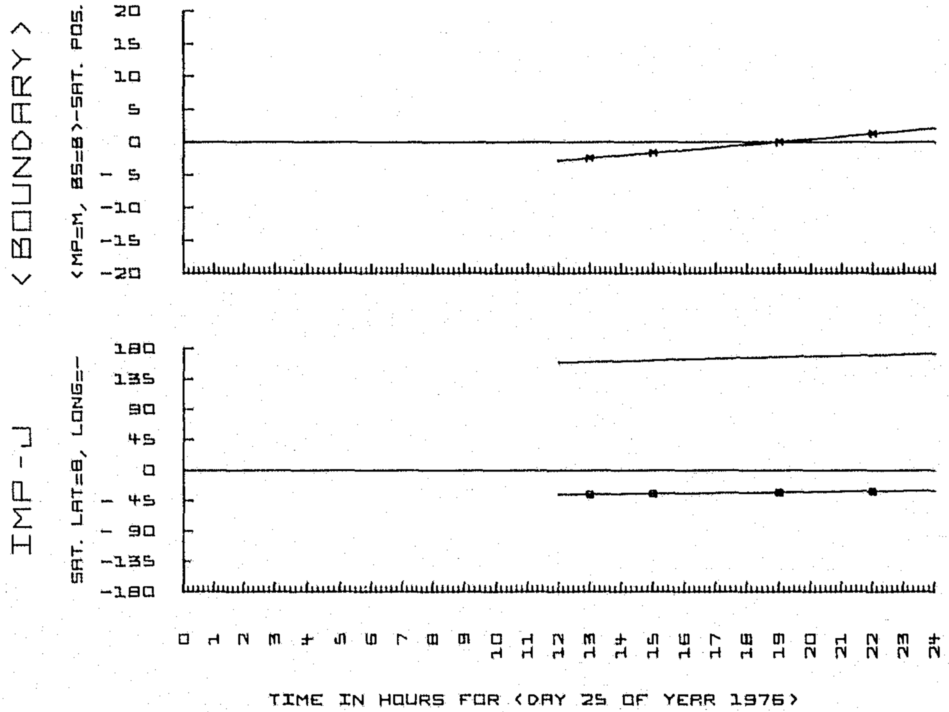


Figure 20. Time Period 3

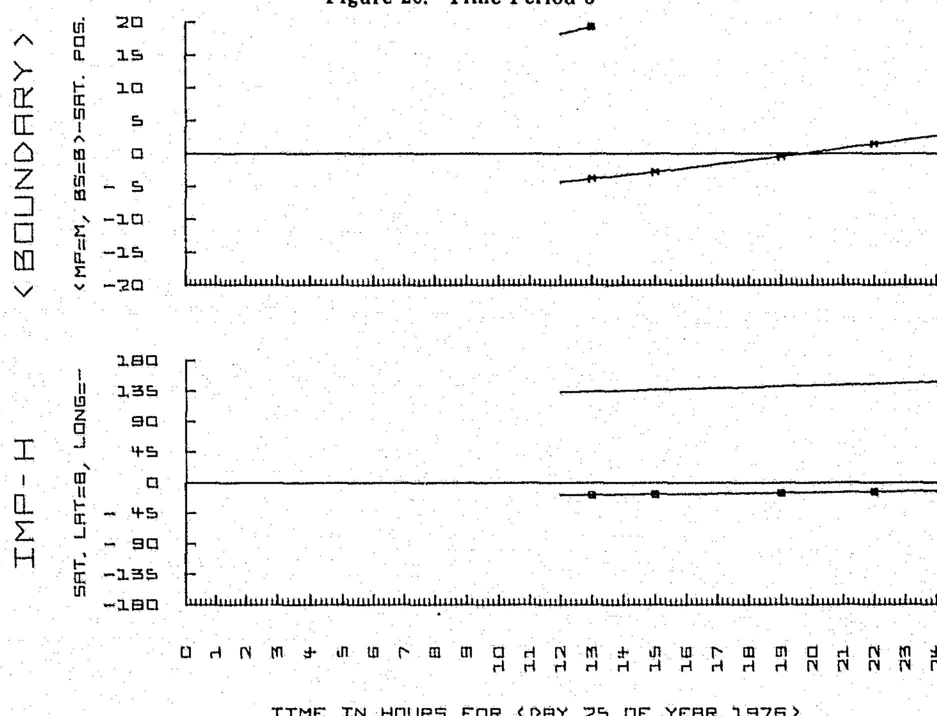


Figure 21. Time Period 3

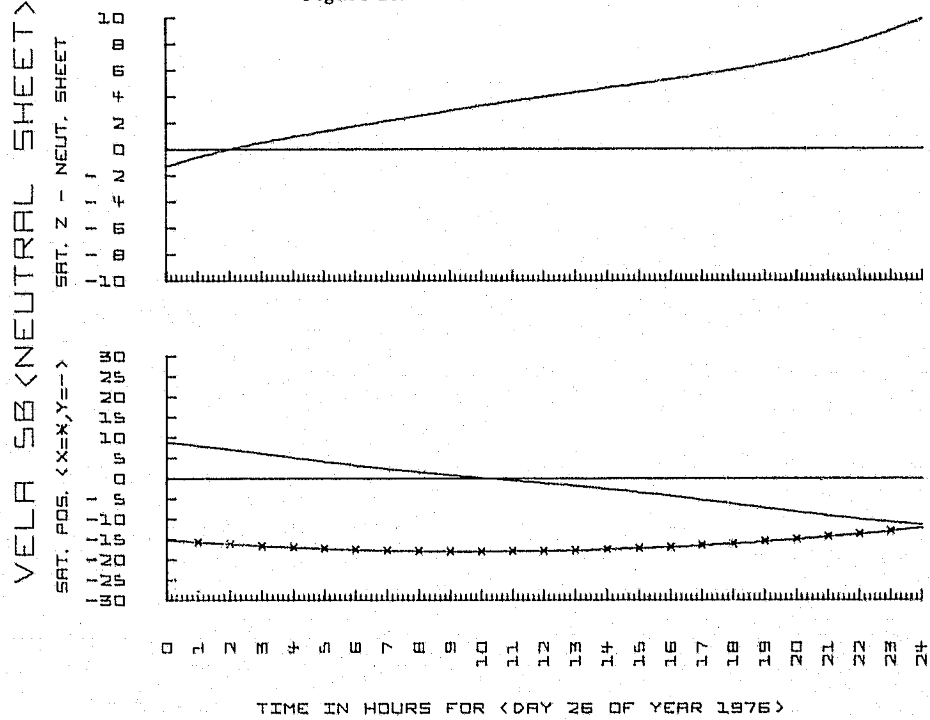


Figure 22. Time Period 3

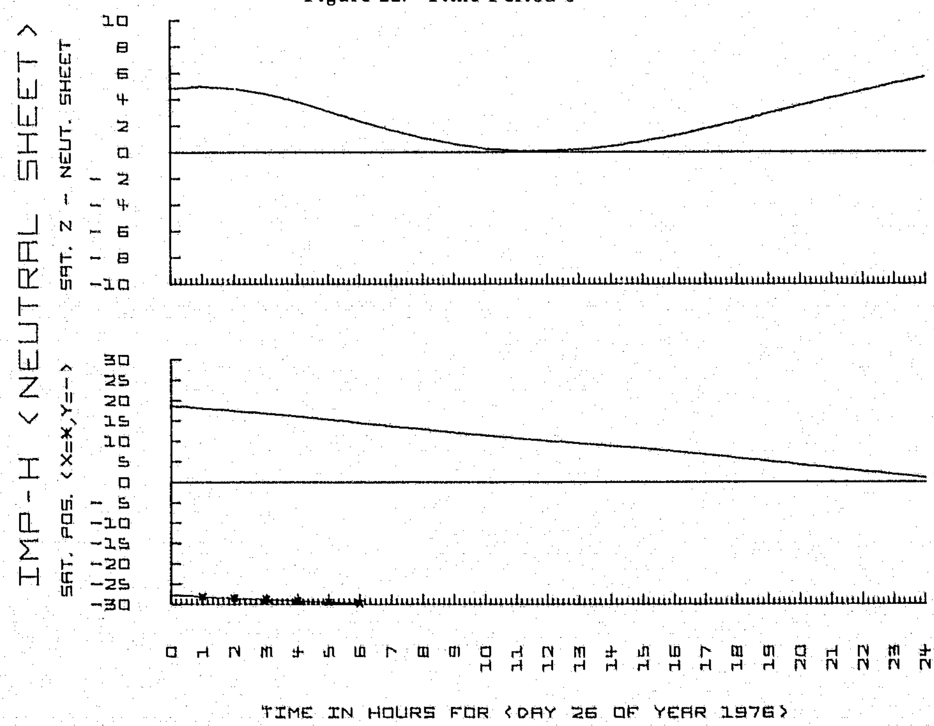


Figure 23. Time Period 3

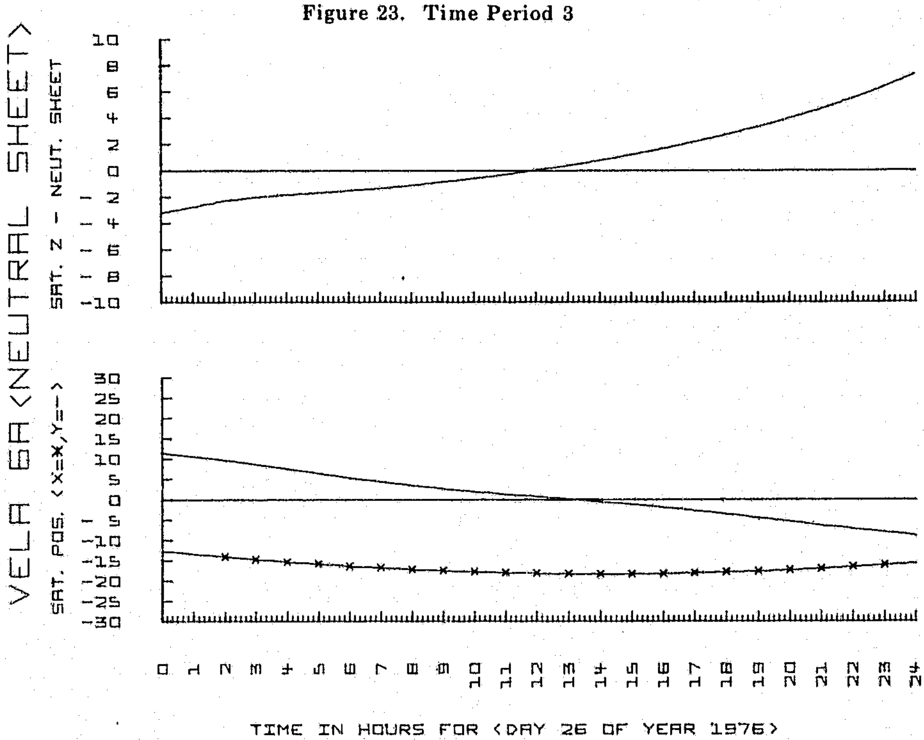


Figure 24. Time Period 4: 1976 Day 28/5h-Day 28/7h

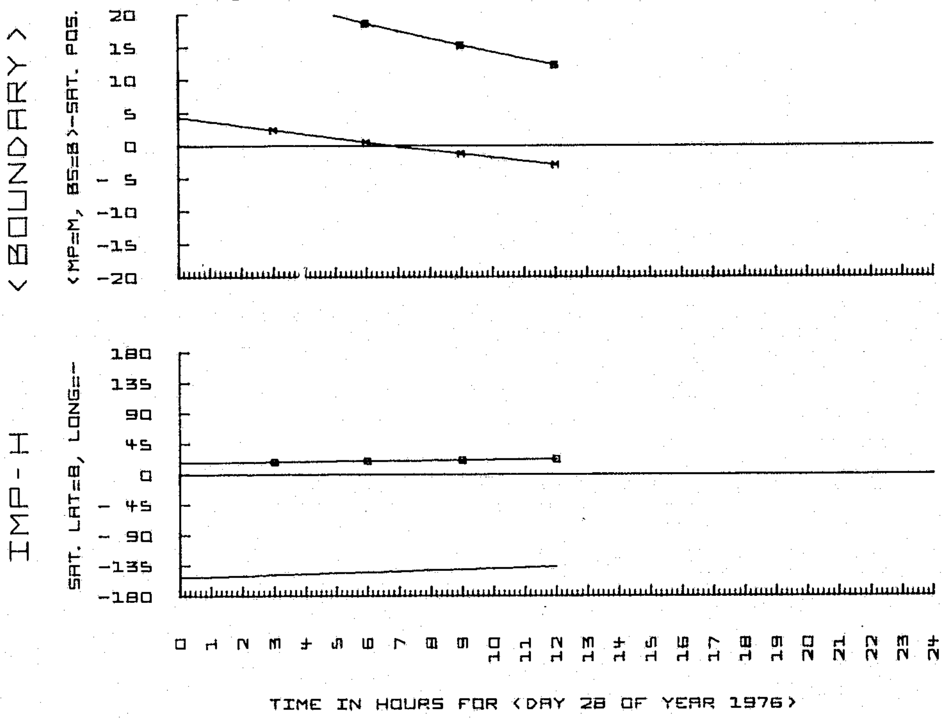


Figure 25. Time Period 4: 1976 Day 28/5h-Day 28/7h

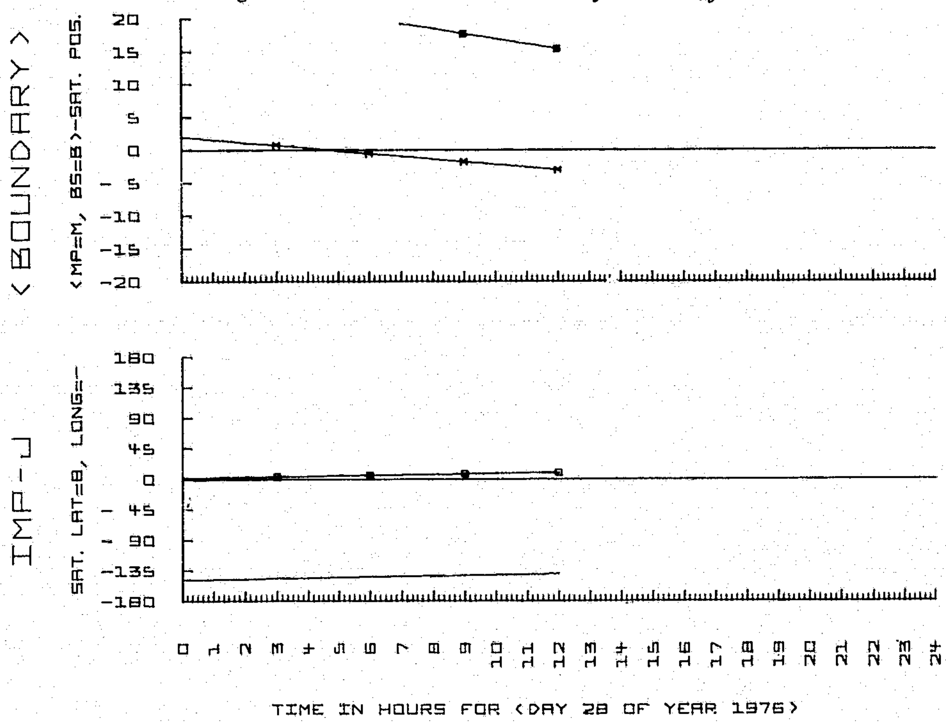
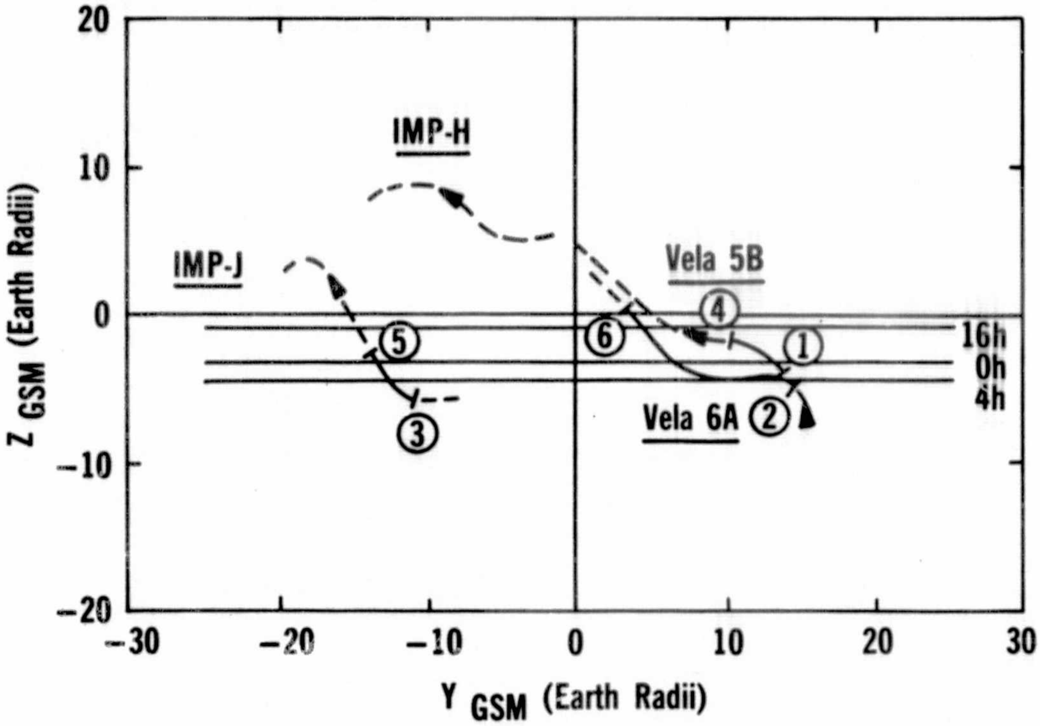


Figure 26

TIME PERIOD 5: 1976 Day 39/21h - 40/14h



Code	Time	Vela 6A Alt. (E.R.)	Vela 5B Alt. (E.R.)	IMP-J Alt. (E.R.)
1	39/21h	17.5	17.4	36.9
2	39/23h	17.5	17.3	36.8
3	39/24h	17.4	17.3	36.8
4	40/2h	17.4	17.2	36.7
5	40/4h	17.4	17.2	36.6
6	40/14h	17.3	16.9	36.2

Figure 27. Time Period 5

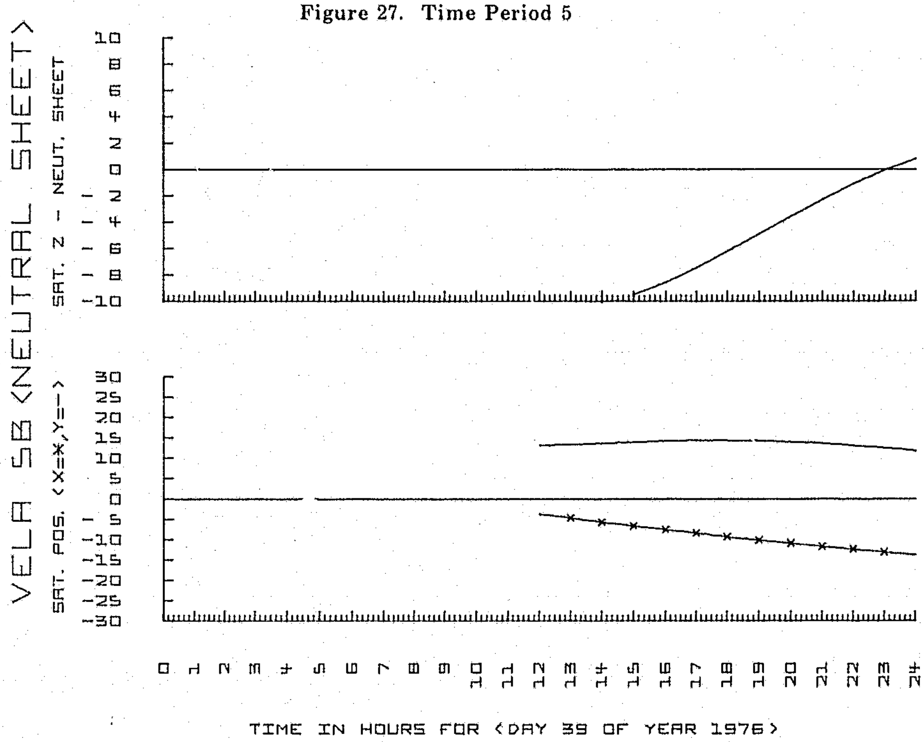


Figure 28. Time Period 5

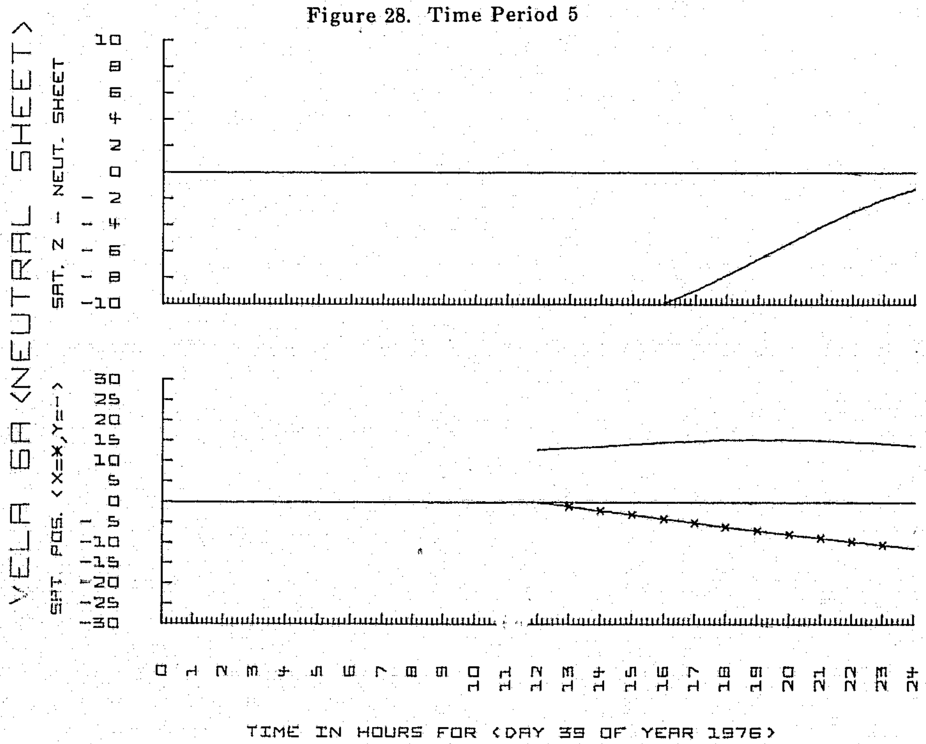


Figure 29. Time Period 5

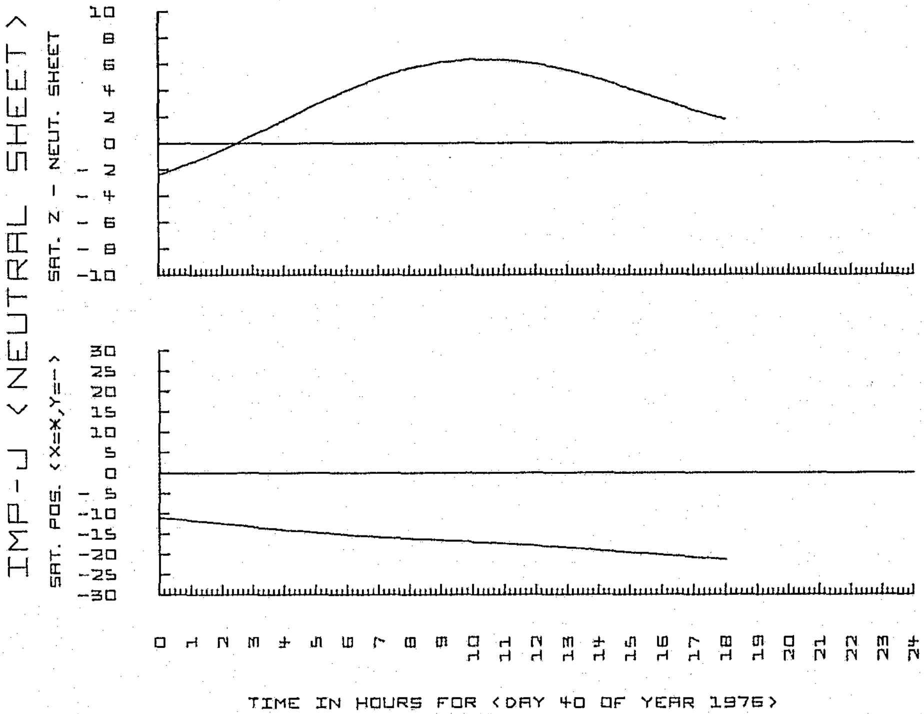


Figure 30. Time Period 5

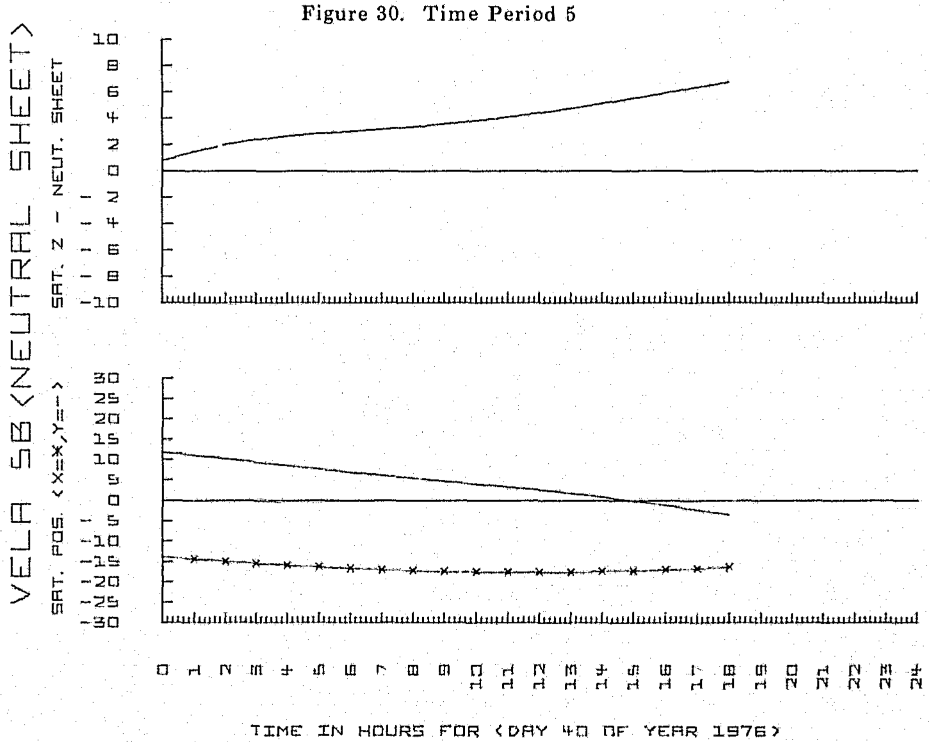


Figure 31. Time Period 5

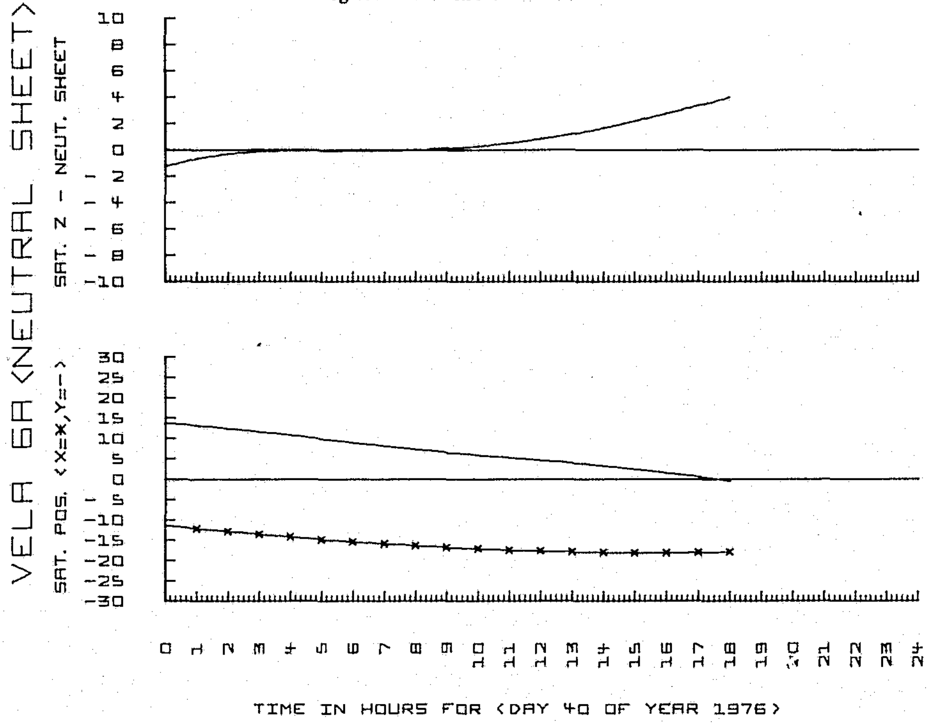
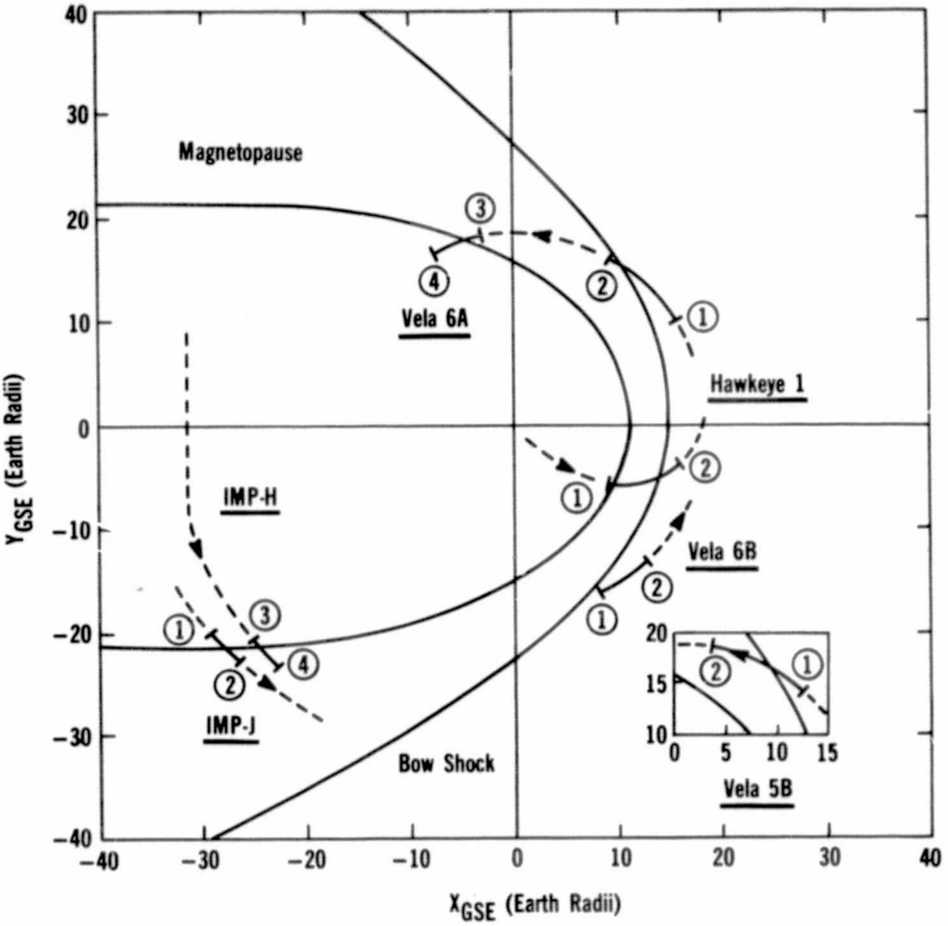


Figure 32

TIME PERIOD 6: 1976 Day 53/2h - Day 53/22h



Code	Time	Vela 5B	Vela 6A	IMP-H	IMP-J	Hawkeye 1	Vela 6B
1	53/2h	I	I	HT	HT	DM	DS
2	53/8h	DS	DS	HT	NS	DS	I
3	53/17h	NM	NS	HT	NS	DS	I
4	53/22h	NM	NM	NS	NS	DS	I

Bow Shock Crossings

Time	Sat.	Direct.	Lat. (deg)
53/3h	Vela 6B	Out	39.0
53/4h	Vela 5B	In	−53.5
53/4.5h	Vela 6A	In	−52.5

Magnetopause Crossings

Time	Sat.	Direct.	Lat. (deg)
53/3.5h	Hawkeye 1	Out	65.5
53/5h	IMP-J	Out	22.4
53/18.5h	Vela 6A	In	−44.4
53/19h	IMP-H	Out	24.8

Figure 33. Time Period 6

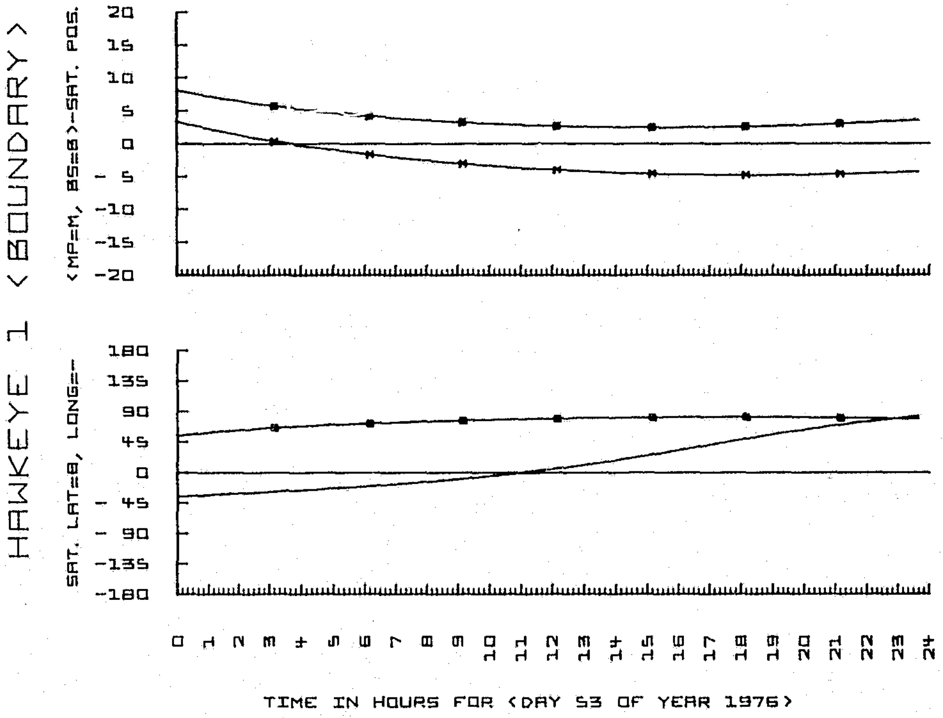


Figure 34. Time Period 6

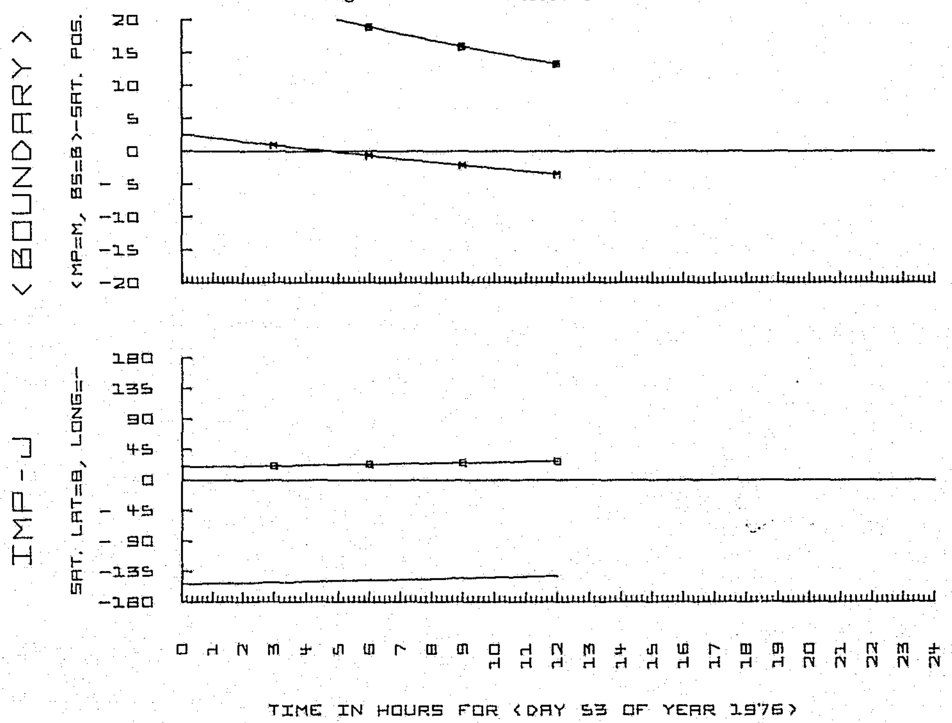


Figure 35. Time Period 6

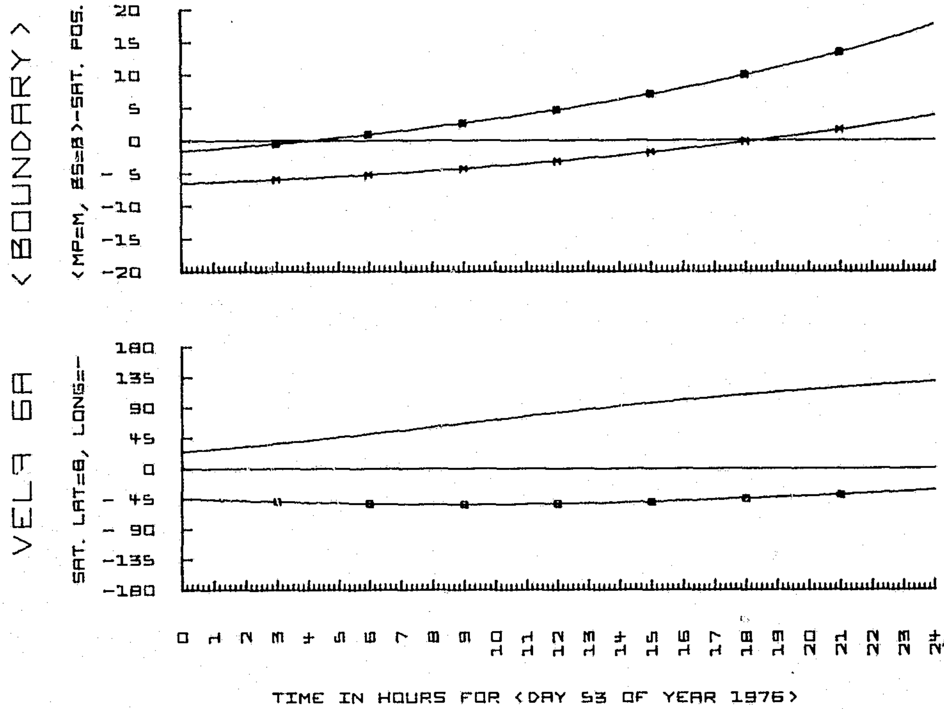


Figure 36. Time Period 6

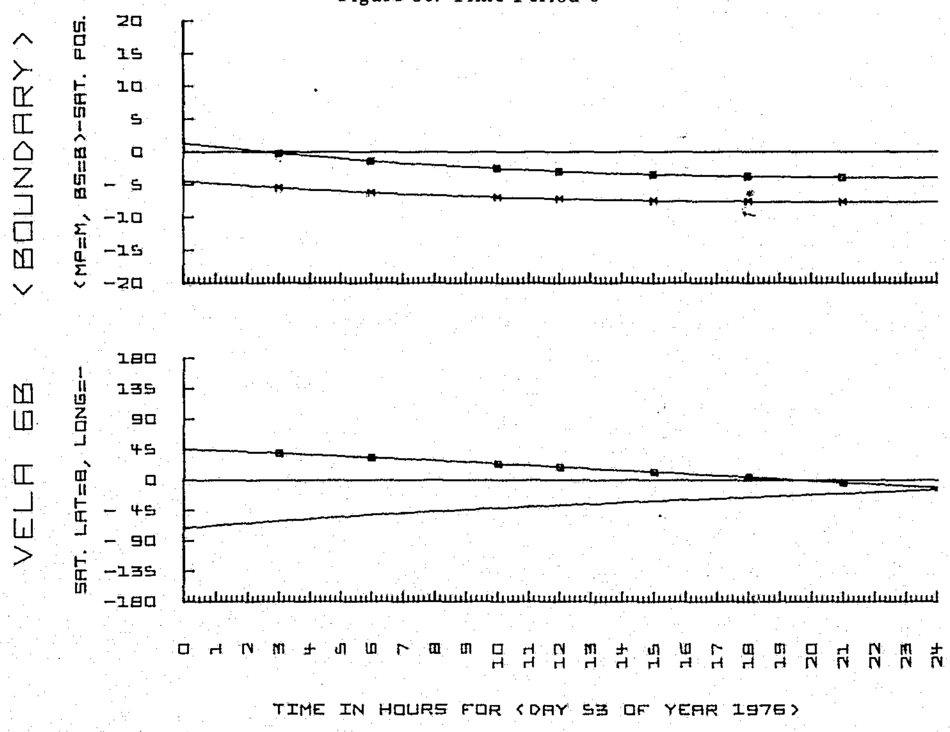


Figure 37. Time Period 6

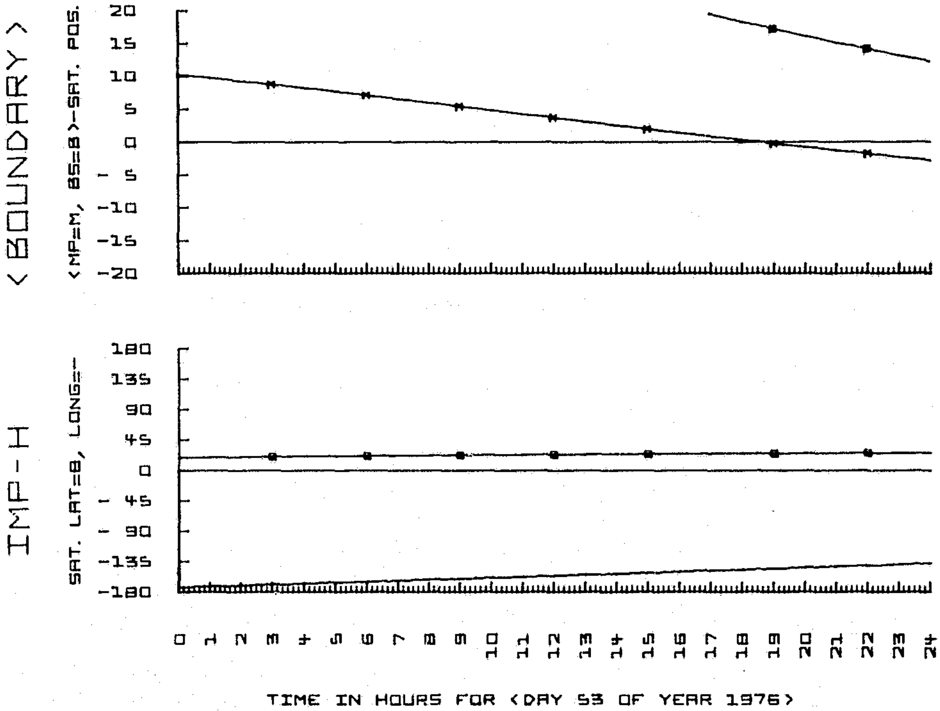
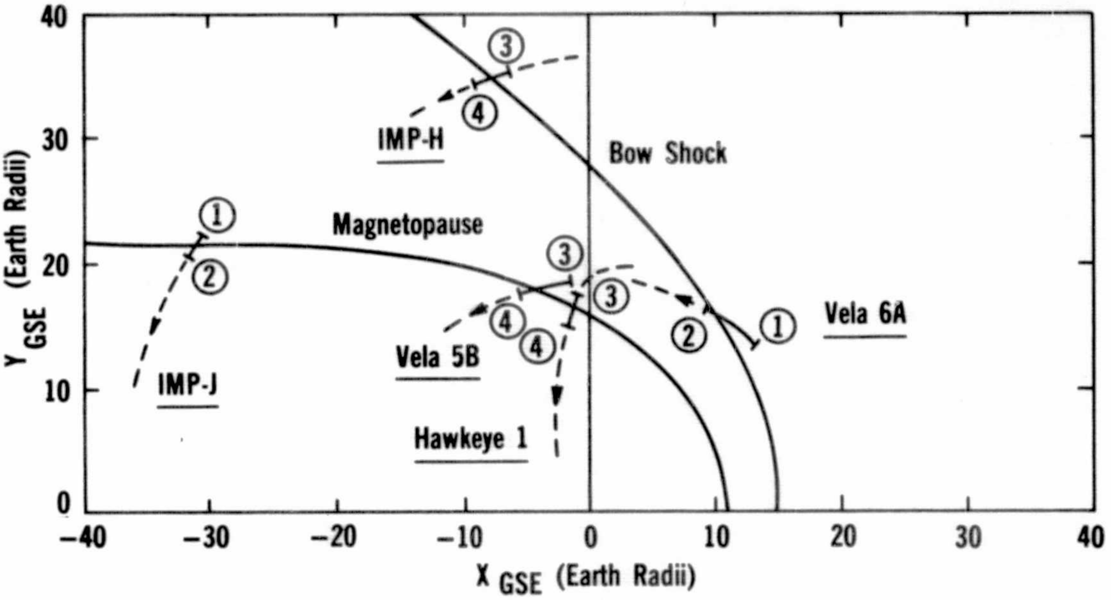


Figure 38

TIME PERIOD 7: 1976 Day 62/13h - 63/20h

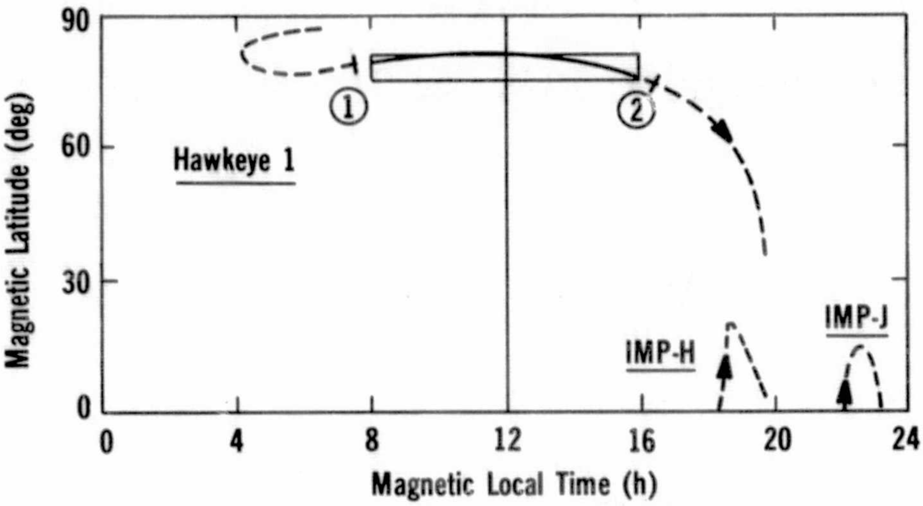


Code	Time	Vela 5B	Vela 6A	IMP-J	IMP-H	Hawkeye 1
1	62/13 h	DS	S	NS	I	DS
2	62/17 h	DS	DS	MT	I	DS
3	62/22 h	NS	NS	Sh	I	NS
4	63/2 h	NM	NS	Sh	NS	C

Bow Shock Crossings				Magnetopause Crossings			
Time	Sat.	Direct.	Lat. (deg)	Time	Sat.	Direct.	Lat. (deg)
62/13 h	Vela 6A	In	−53.3	62/15 h	IMP-J	In	−19.6
62/24 h	IMP-H	In	−13.5	63/1 h	Vela 5B	In	−37.8
				62/23.5 h	Hawkeye 1	In	67.6

Figure 39

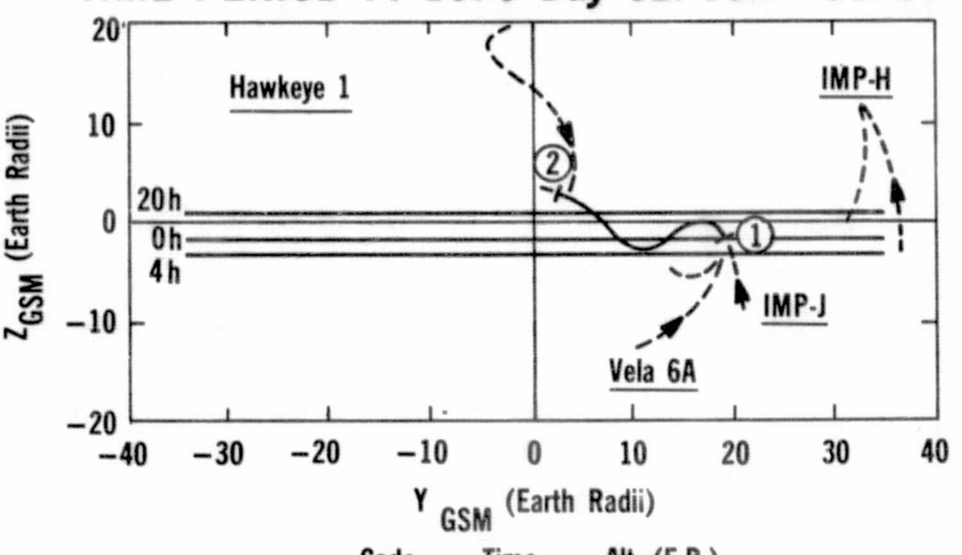
TIME PERIOD 7: 1976 Day 62/13h - 63/20h



Code	Time	Alt. (E.R.)
1	63/0 h	15.2
2	63/5.5 h	10.5

Figure 40

TIME PERIOD 7: 1976 Day 62/13h - 63/20h



Code	Time	Alt. (E.R.)
1	62/19.5 h	36.71
2	63/20 h	35.84

Figure 41. Time Period 7

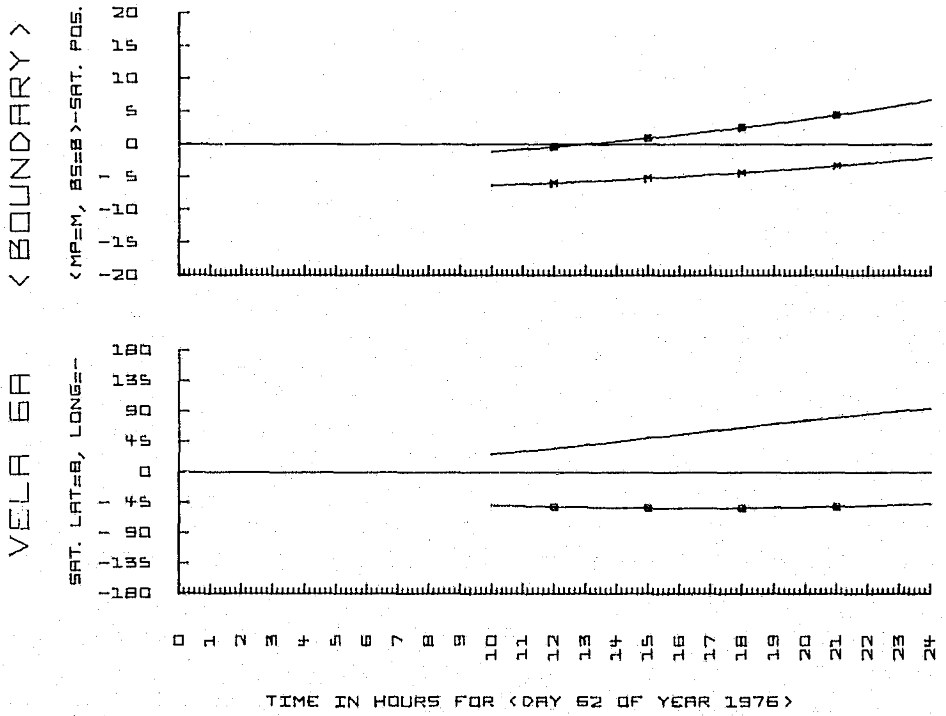


Figure 42. Time Period 7

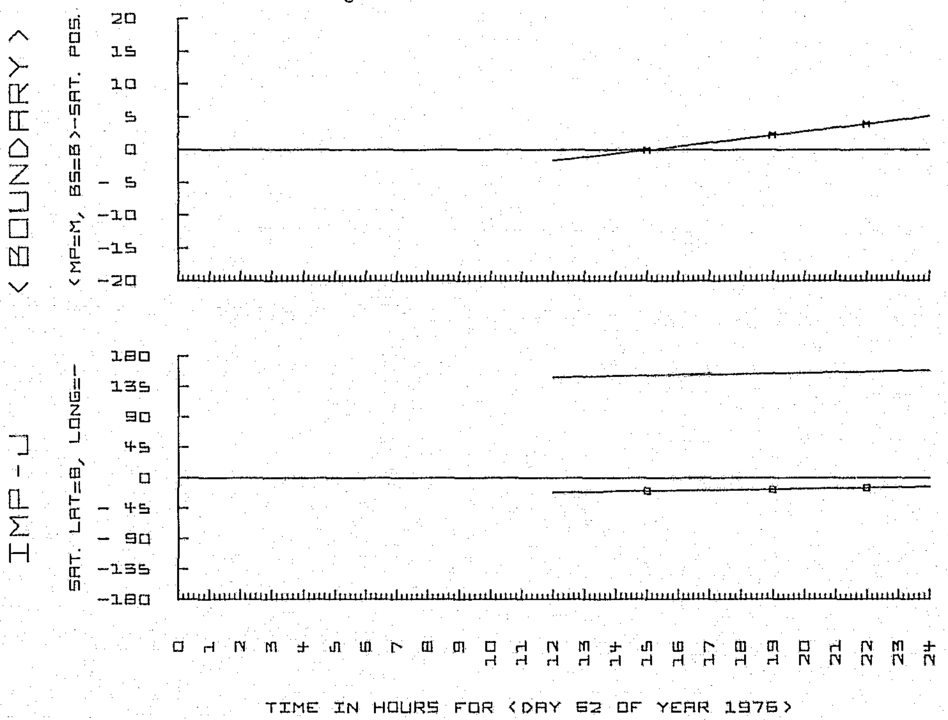


Figure 43. Time Period 7

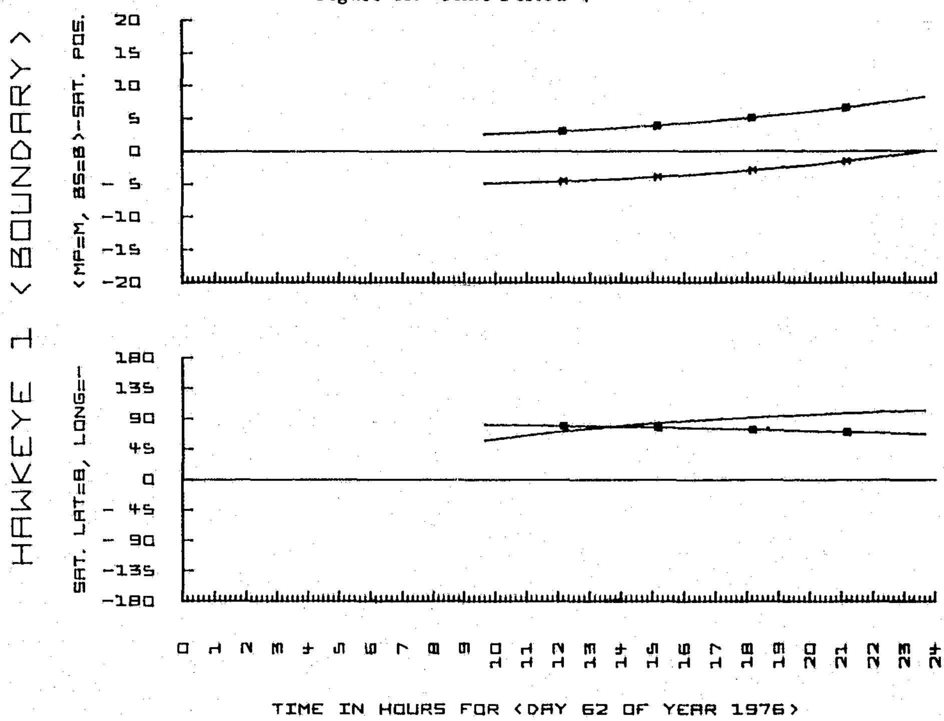


Figure 44. Time Period 7

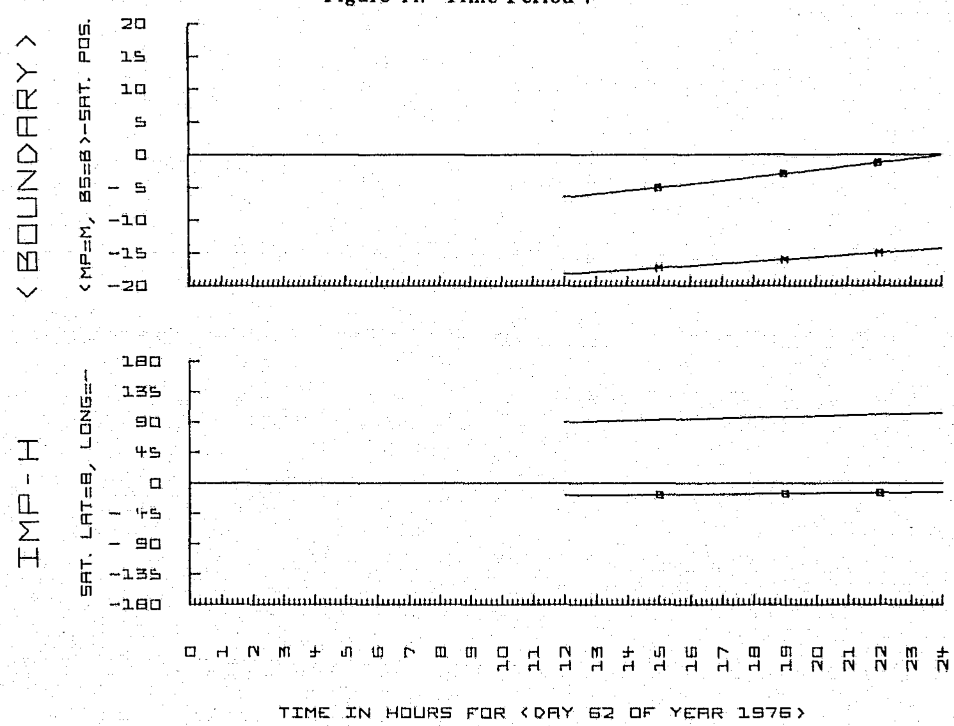


Figure 45. Time Period 7

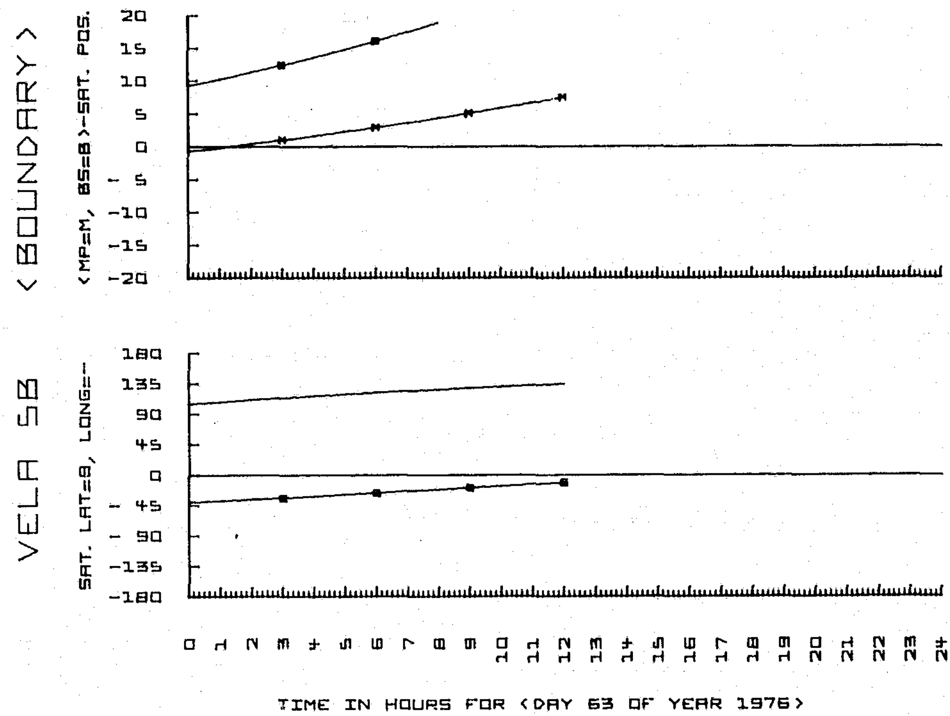


Figure 46. Time Period 7

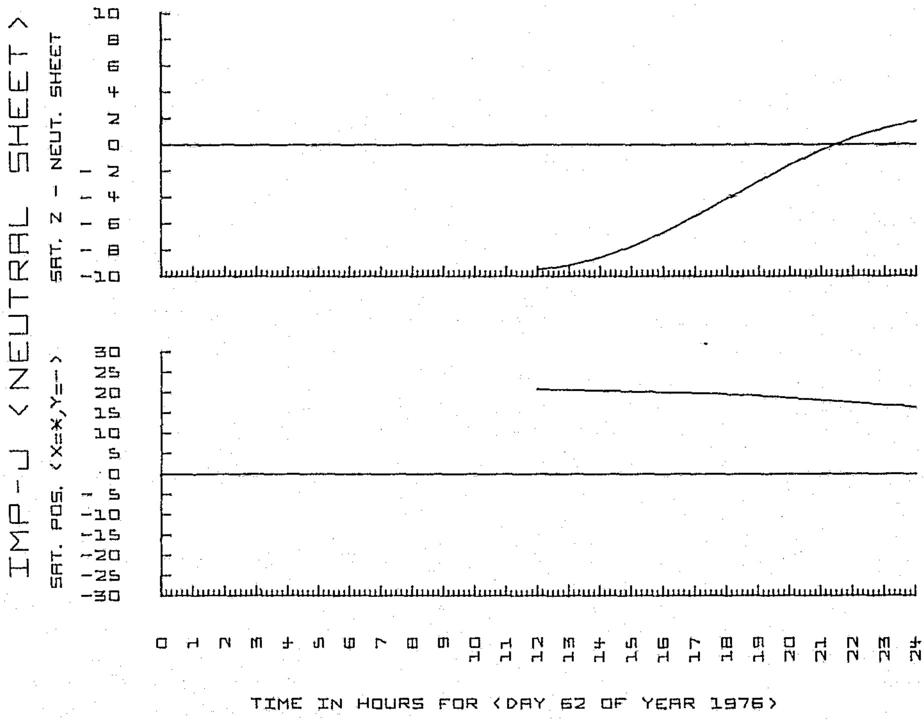


Figure 47. Time Period 7

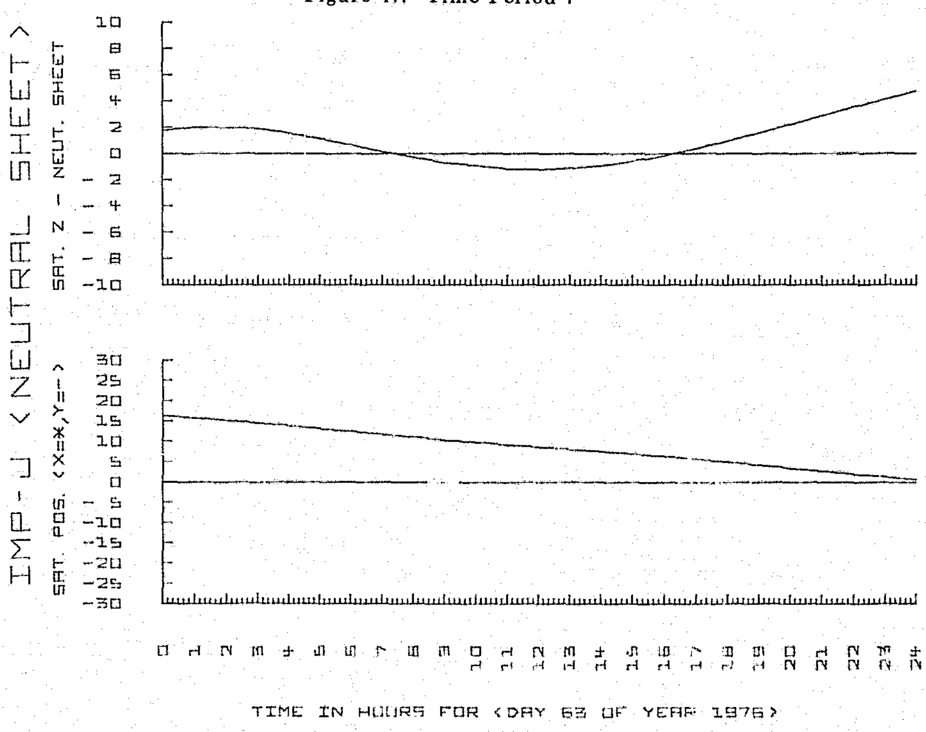
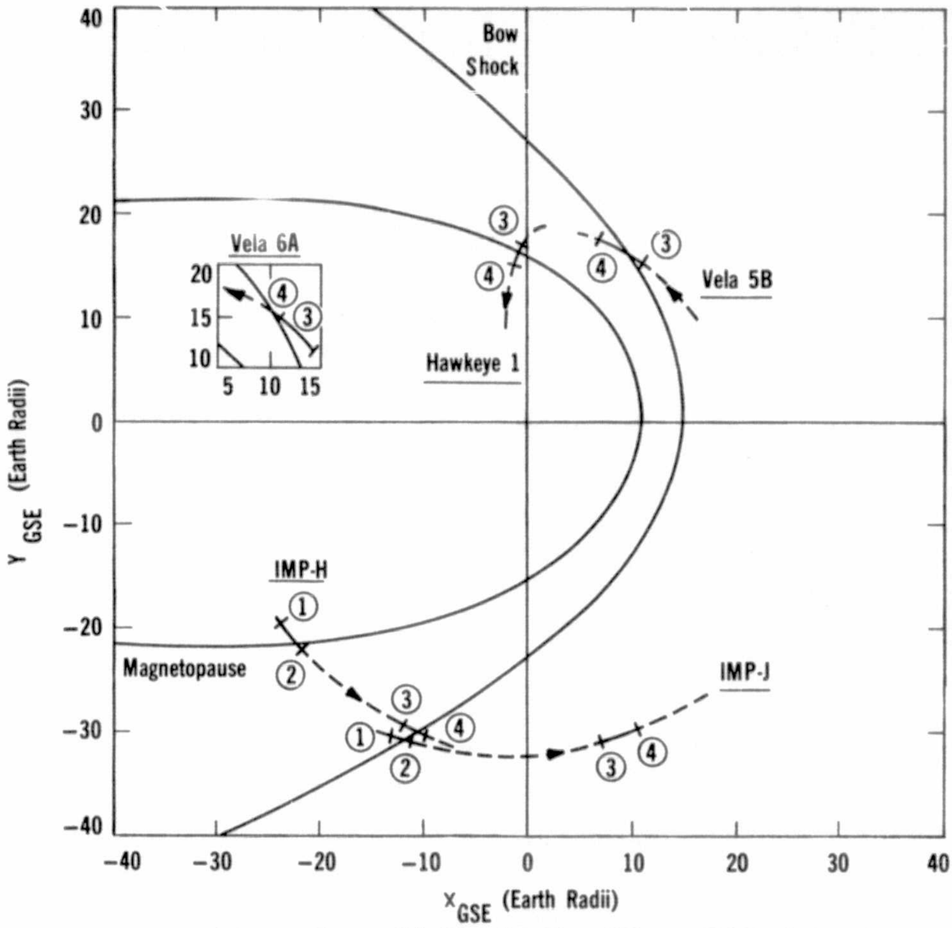


Figure 48

TIME PERIOD 8: 1976 Day 66/8h - 67/9h



Code	Time	Vela 5B	Vela 6A	IMP-J	IMP-H	Hawkeye 1
1	66/8 h	I	I	NS	HT	DS
2	66/12 h	I	I	I	NS	DS
3	67/5 h	DS	I	I	NS	NS
4	67/8 h	DS	DS	I	I	NM

Bow Shock Crossings

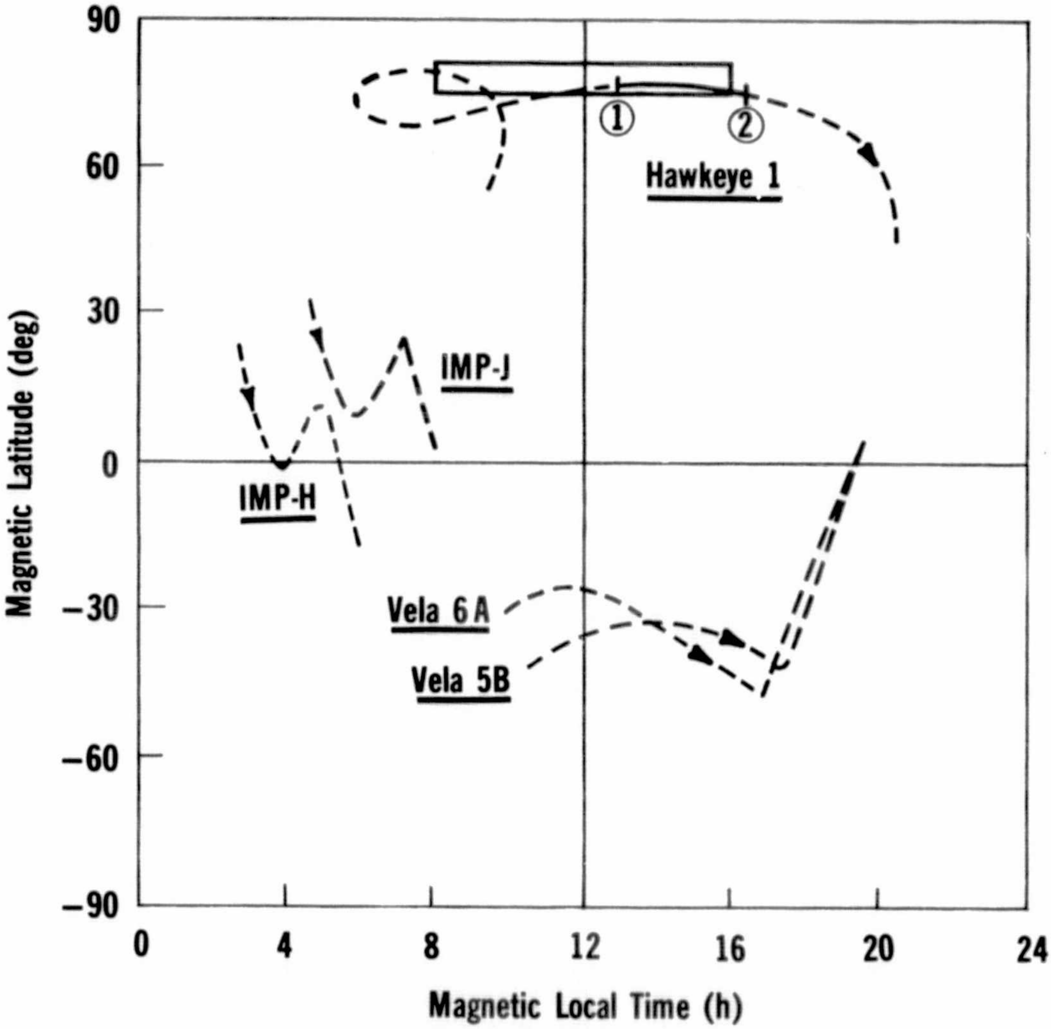
Time	Sat.	Direct.	Lat. (deg)
66/11 h	IMP-J	Out	40.3
67/3 h	Vela 5B	In	−53.5
67/7 h	IMP-H	Out	21.8
67/5.5 h	Vela 6A	In	−52.0

Magnetopause Crossings

Time	Sat.	Direct.	Lat. (deg)
66/11.5 h	IMP-H	Out	25.5
67/6.5 h	Hawkeye 1	In	67.0

Figure 49

TIME PERIOD 8: 1976 Day 66/8h - 67/9h



Code	Time	Alt. (E.R.)
1	67/6.5h	15.5
2	67/8.3 h	13.8

Figure 50. Time Period 8

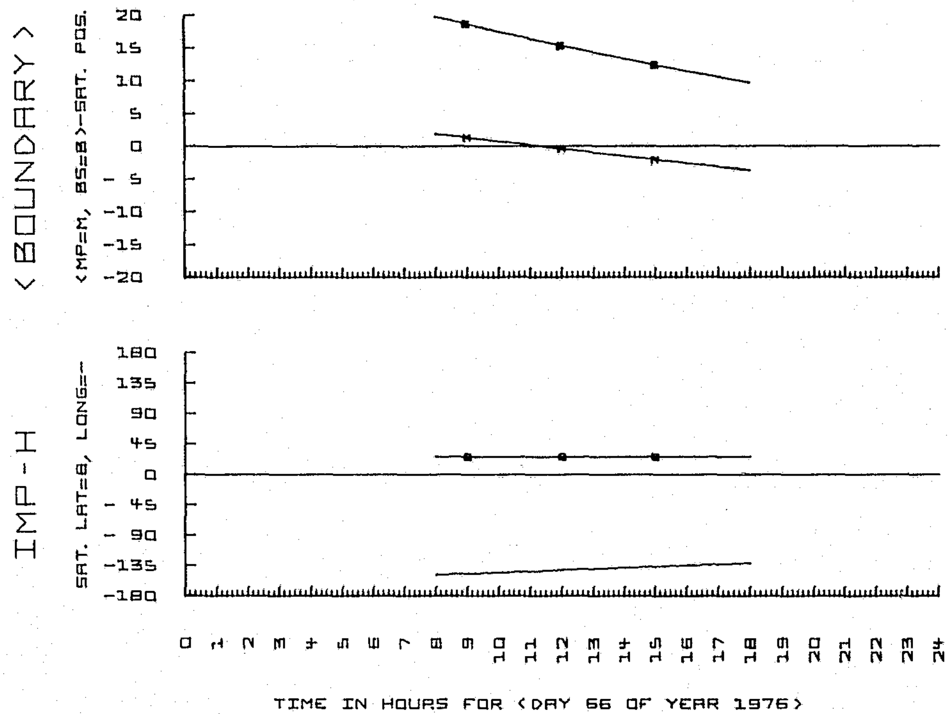


Figure 51. Time Period 8

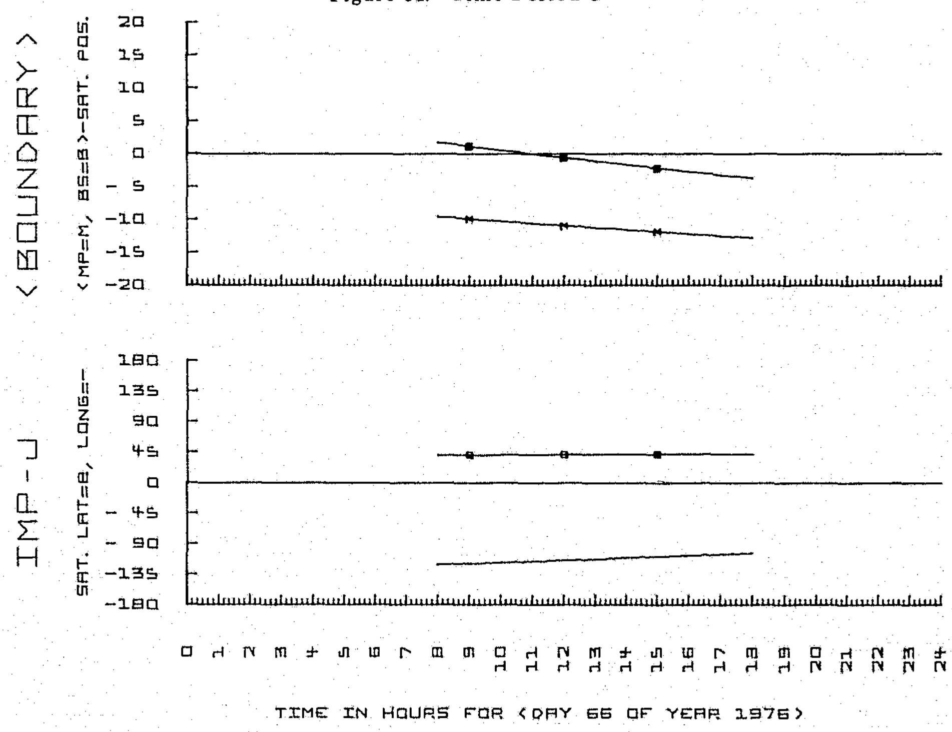


Figure 52. Time Period 8

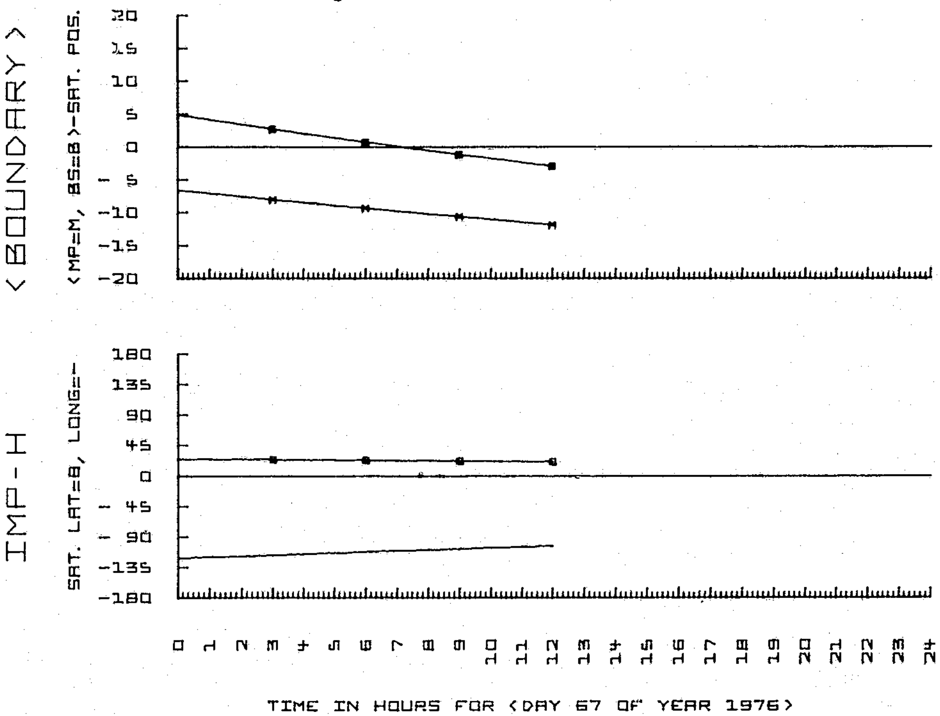


Figure 53. Time Period 8

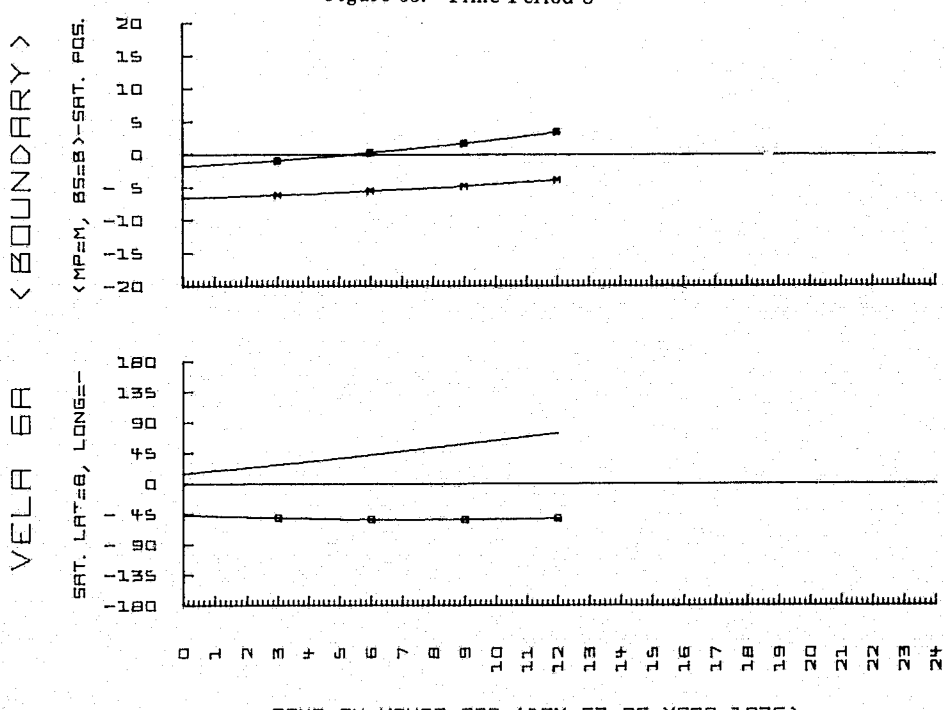


Figure 54. Time Period 8

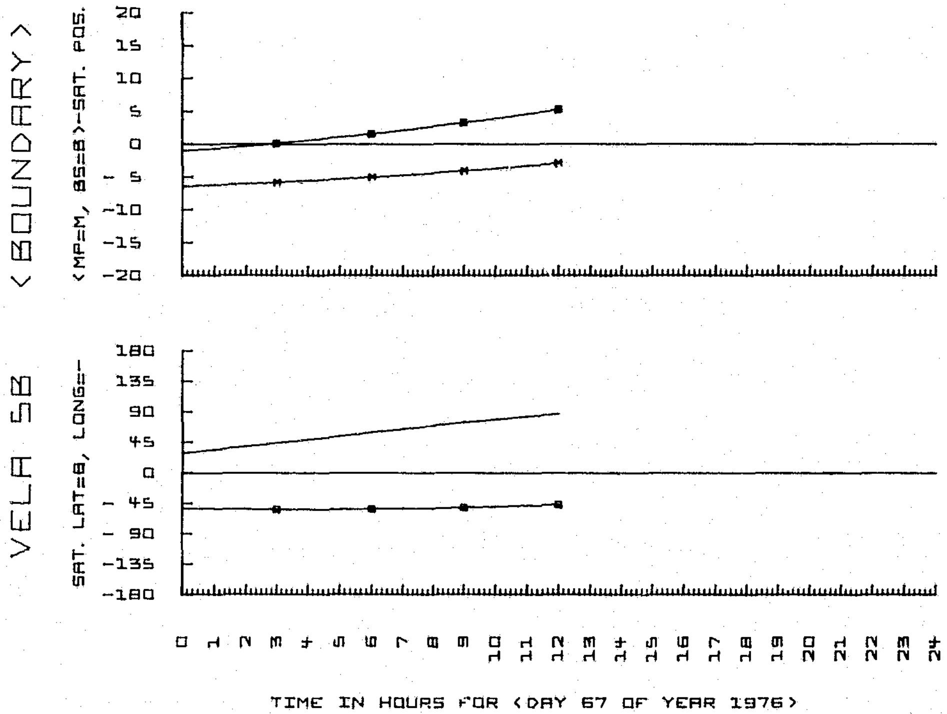


Figure 55. Time Period 8

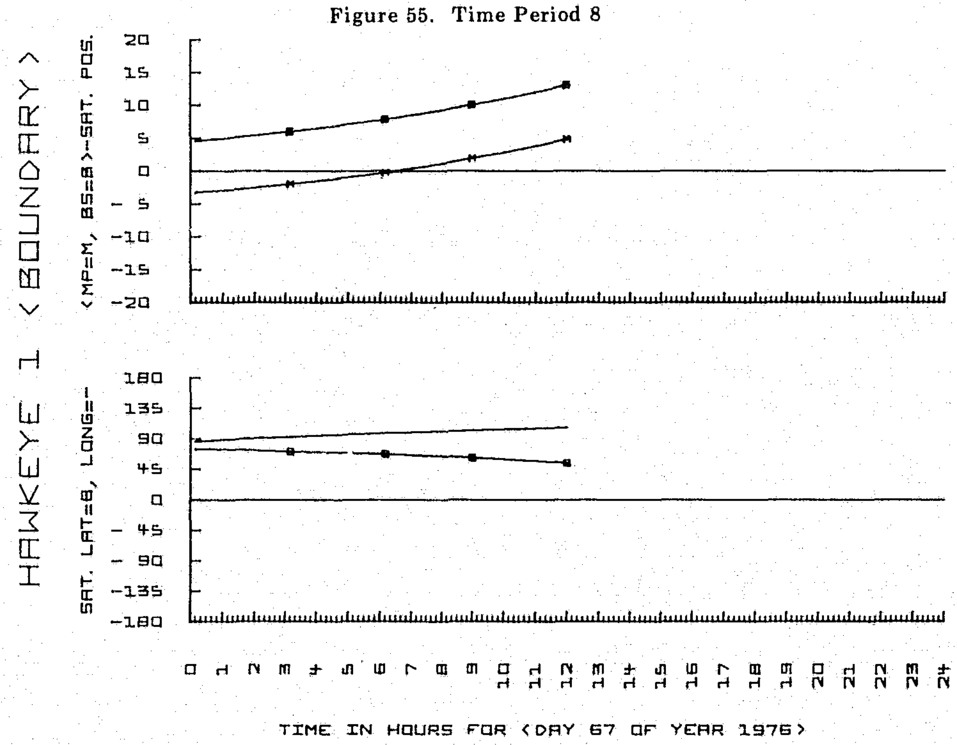
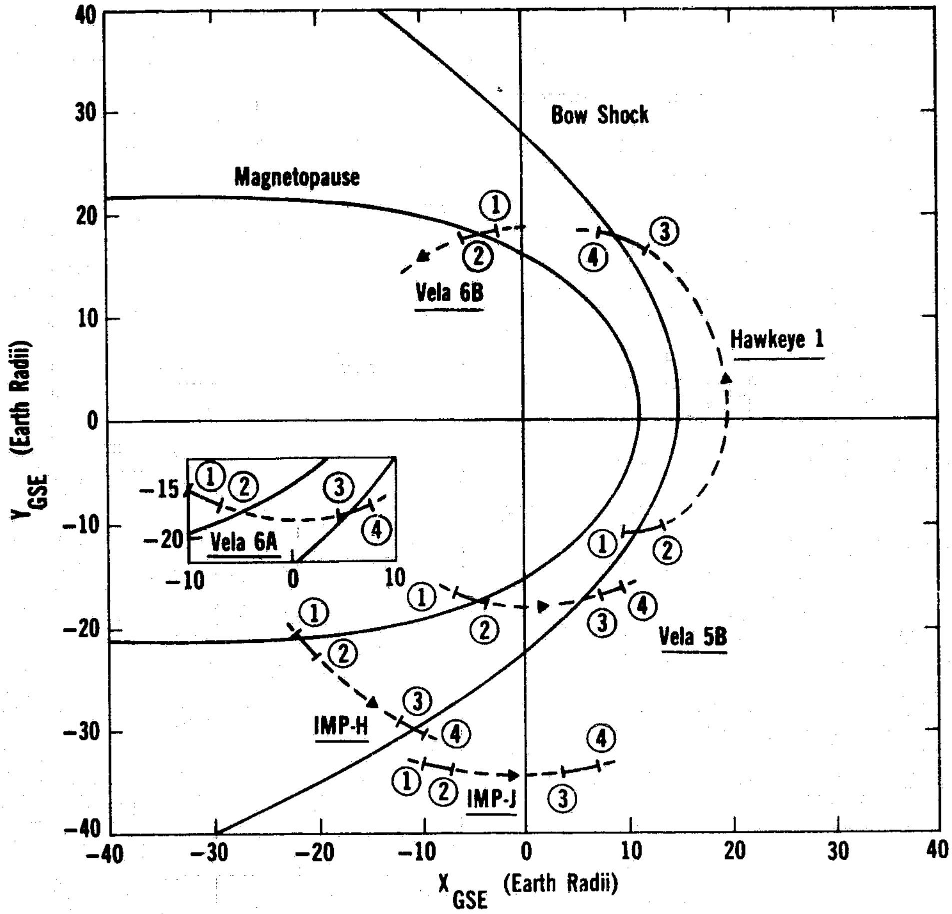


Figure 56

TIME PERIOD 9: 1976 Day 78/20h - 79/18h



Code	Time	Vela 5B	Vela 6A	IMP-J	IMP-H	Hawkeye 1	Vela 6B
1	78/20 h	NM	NM	I	HT	DS	NS
2	78/24 h	NS	NM	I	NS	DS	NM
3	79/14 h	I	DS	I	NS	DS	HT
4	79/18 h	I	I	I	I	DS	HT

Bow Shock Crossings

Time	Sat.	Direct.	Lat. (deg)
79/12.5 h	Vela 5B	Out	23.0
79/17 h	Vela 6A	Out	25.2
79/11 h	Hawkeye 1	Close Approach	81.2
79/17 h	IMP-H	Out	18.9

Magnetopause Crossings

Time	Sat.	Direct.	Lat. (deg)
78/21.5h	IMP-H	Out	25.0
78/23 h	Vela 5B	Out	48.6
78/22.5h	Vela 6B	In	−30.0
79/3 h	Vela 6A	Out	49.0

Figure 57. Time Period 9

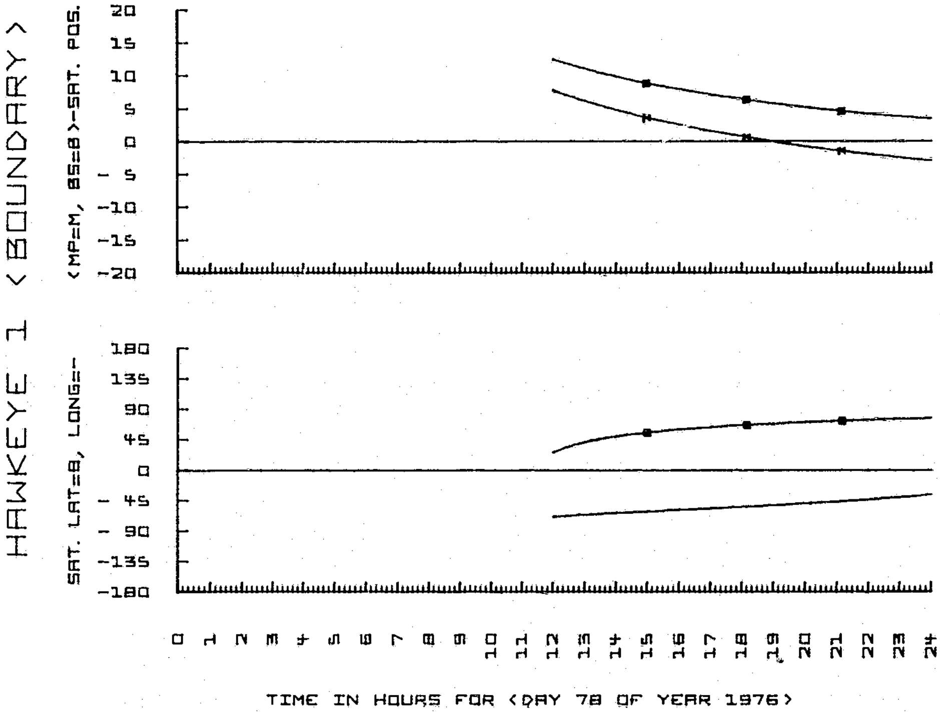


Figure 58. Time Period 9

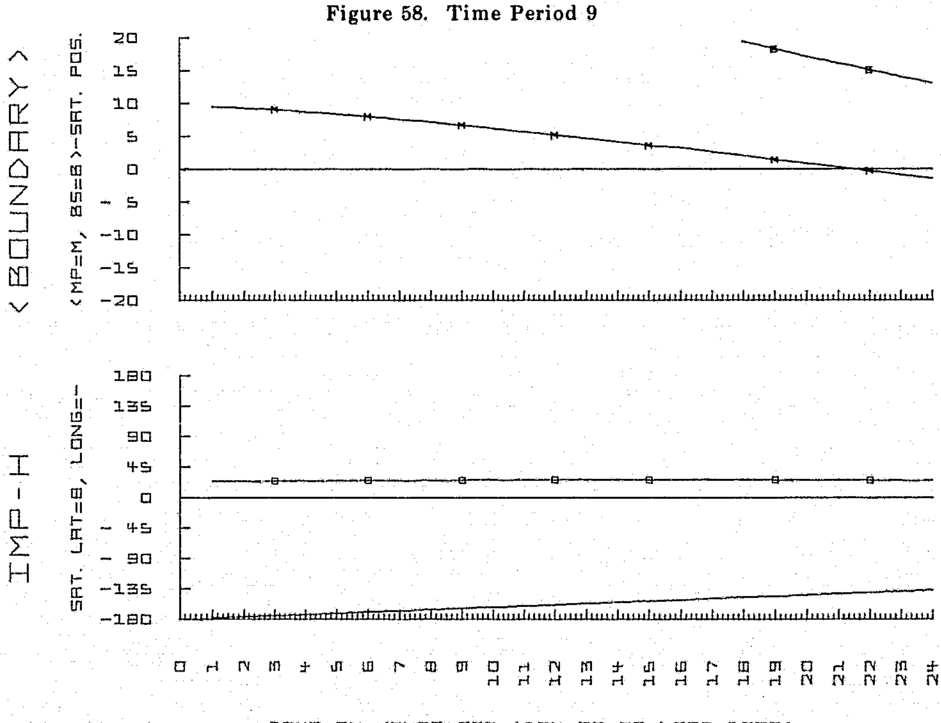


Figure 59. Time Period 9

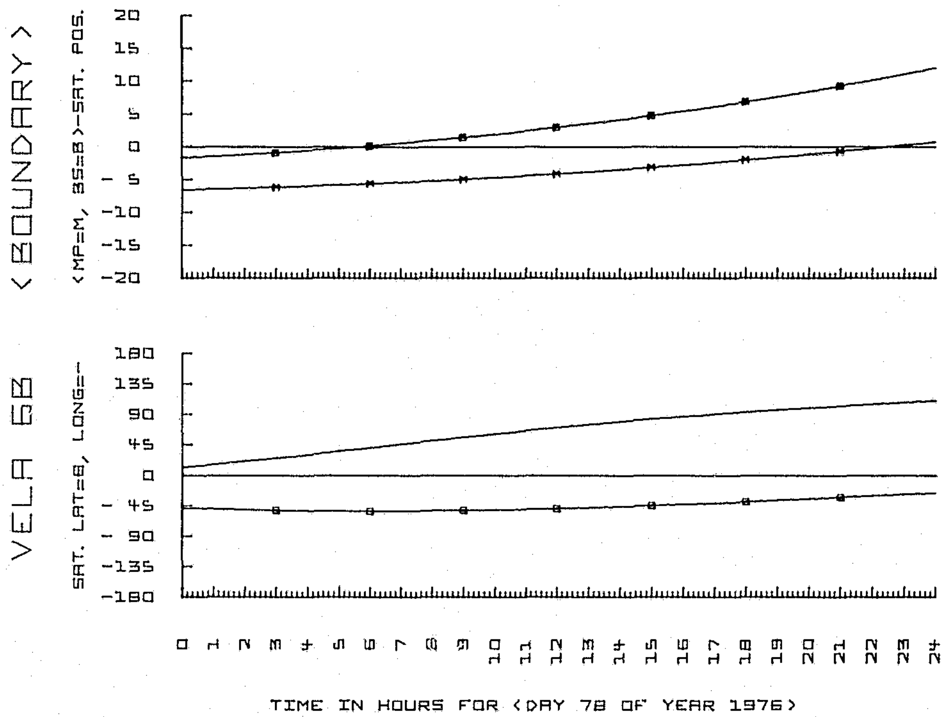


Figure 60. Time Period 9

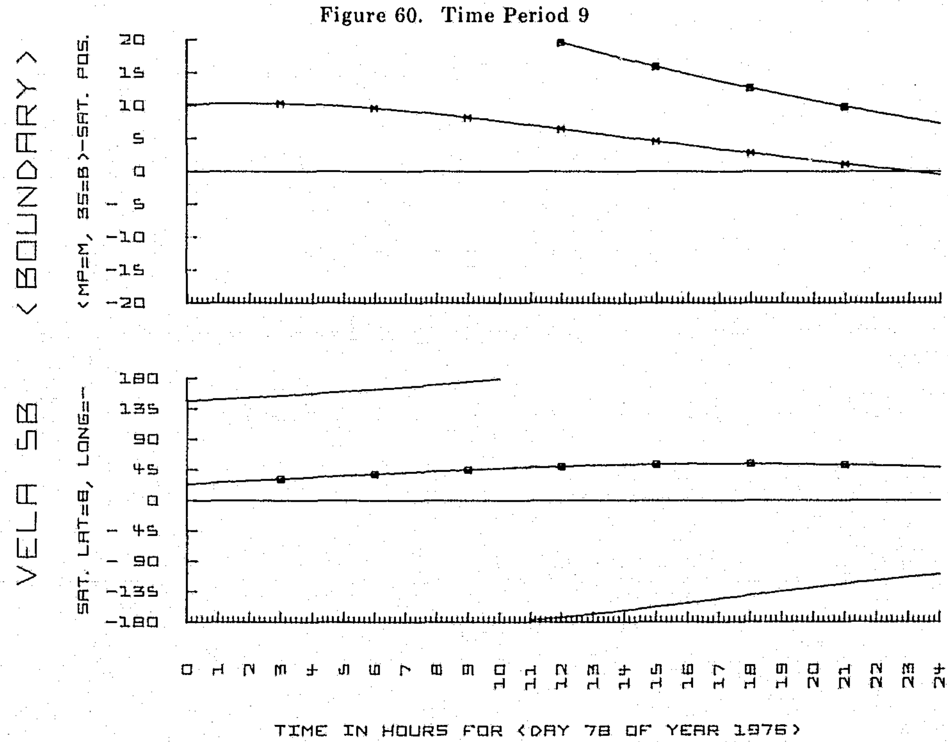


Figure 61. Time Period 9

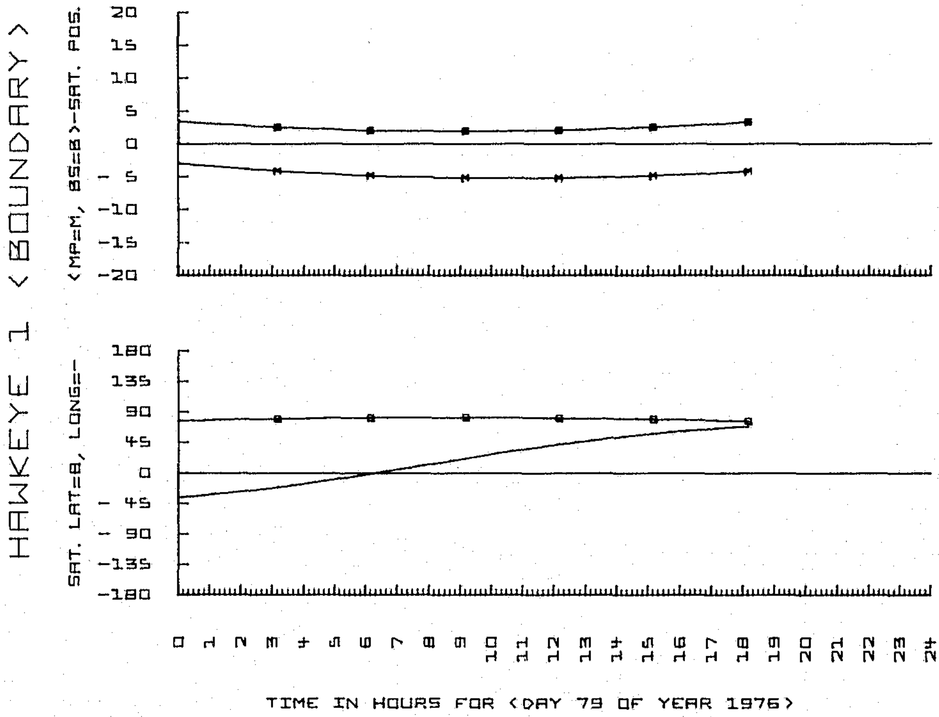


Figure 62. Time Period 9

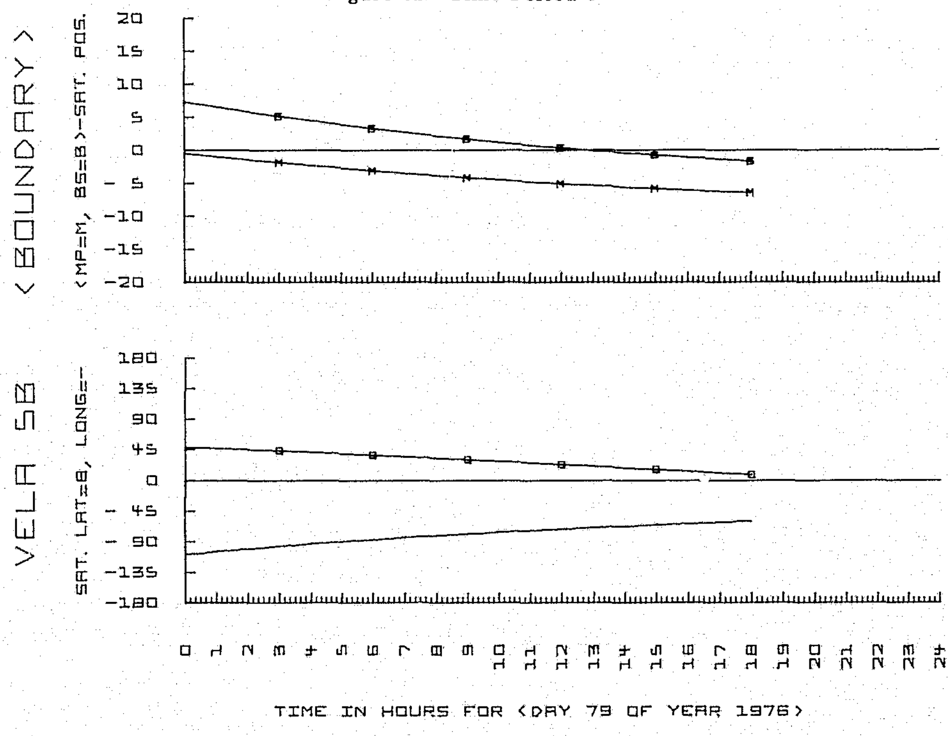


Figure 63. Time Period 9

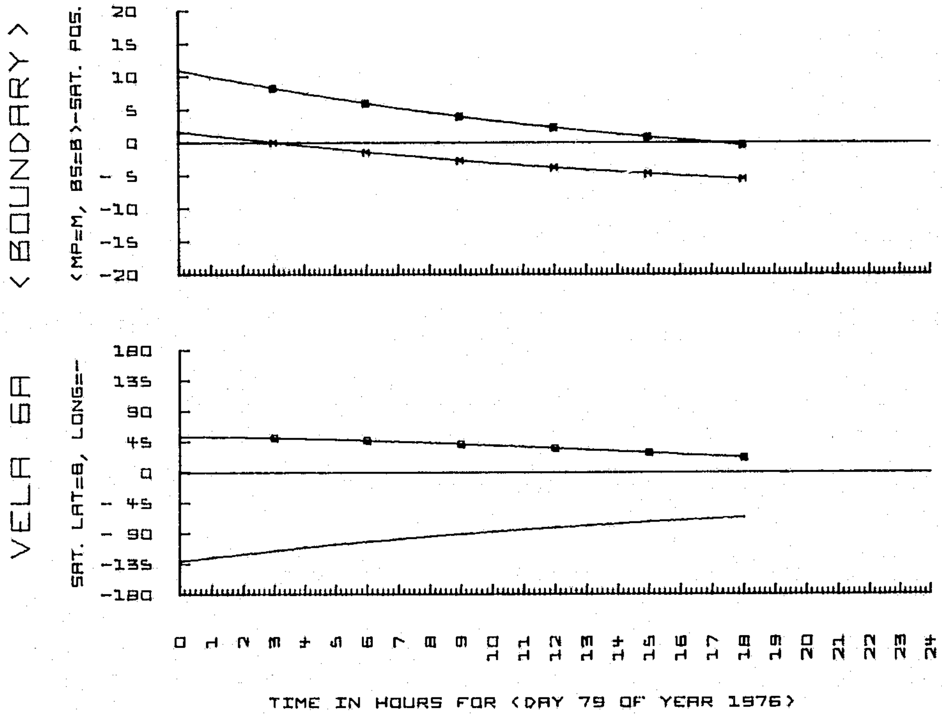


Figure 64. Time Period 9

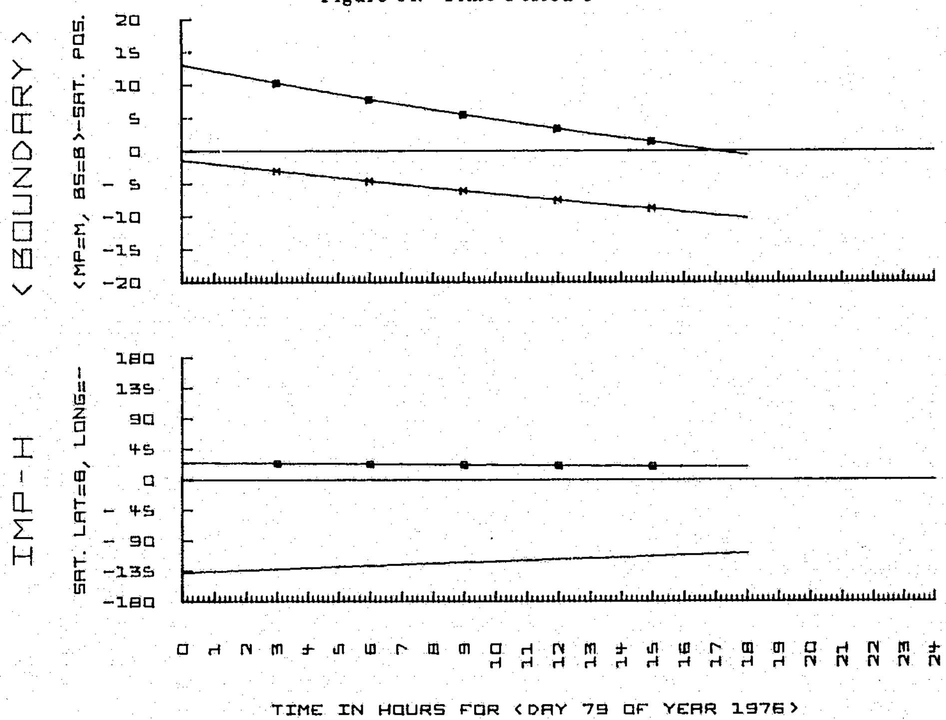
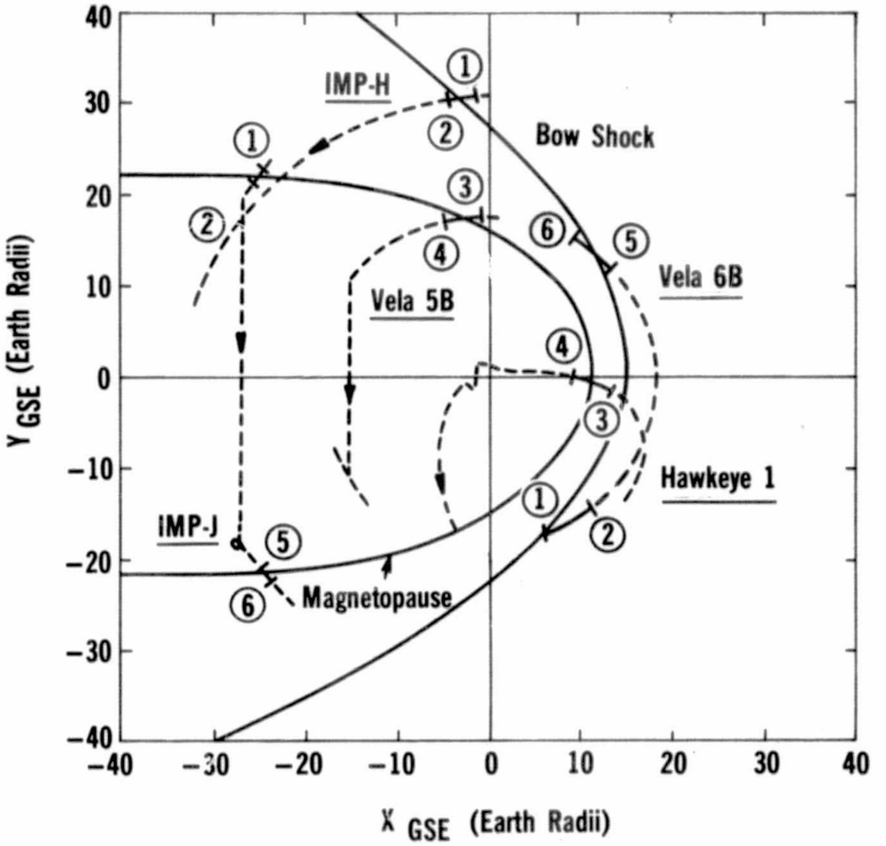


Figure 65

TIME PERIOD 10: 1976 Day 175/20h - 178/11h

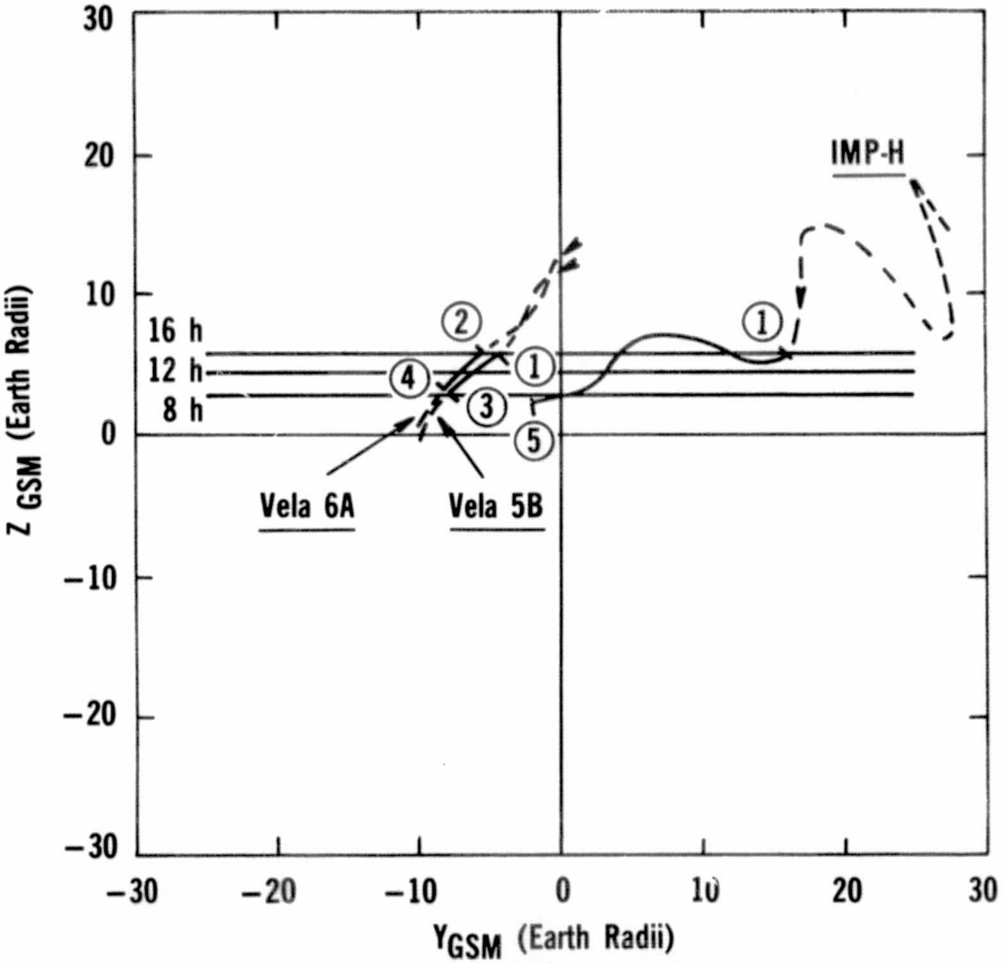


Code	Time	Vela 5B	IMP-H	IMP-J	Hawkeye 1	Vela 6B
1	175/20 h	DS	I	NS	DS	DS
2	175/24 h	DS	NS	HT	DS	I
3	176/6 h	NS	NS	HT	DS	I
4	176/10 h	NM	NS	HT	DM	I
5	177/12 h	Sh	Sh	HT	NS	I
6	177/16 h	MT	Sh	NS	DS	DS

Bow Shock Crossings				Magnetopause Crossings			
Time	Sat.	Direct.	Lat. (deg)	Time	Sat.	Direct.	Lat. (deg)
175/23.5h	Vela 6B	Out	−52.6	175/24 h	IMP-J	In	37.6
175/22 h	IMP-H	In	25.2	176/9 h	Vela 5B	In	51.4
177/22 h	Hawkeye 1	Close Approach	79.5	176/7 h	Hawkeye 1	In	57.1
177/12.5h	Vela 6B	In	27.4	177/14 h	IMP-J	Out	11.4

Figure 66

TIME PERIOD 10: 1976 Day 175/20h - 178/11h



Code	Time	Vela 5B Alt. (E.R.)	IMP-H Alt. (E.R.)	Vela 6A Alt. (E.R.)
1	177/9.5 h	17.8	31.2	17.5
2	177/11.5h	17.8	31.3	17.5
3	177/13 h	17.9	31.4	17.5
4	177/15 h	17.9	31.5	17.6
5	178/11 h	18.1	33.3	17.6

Figure 67. Time Period 10

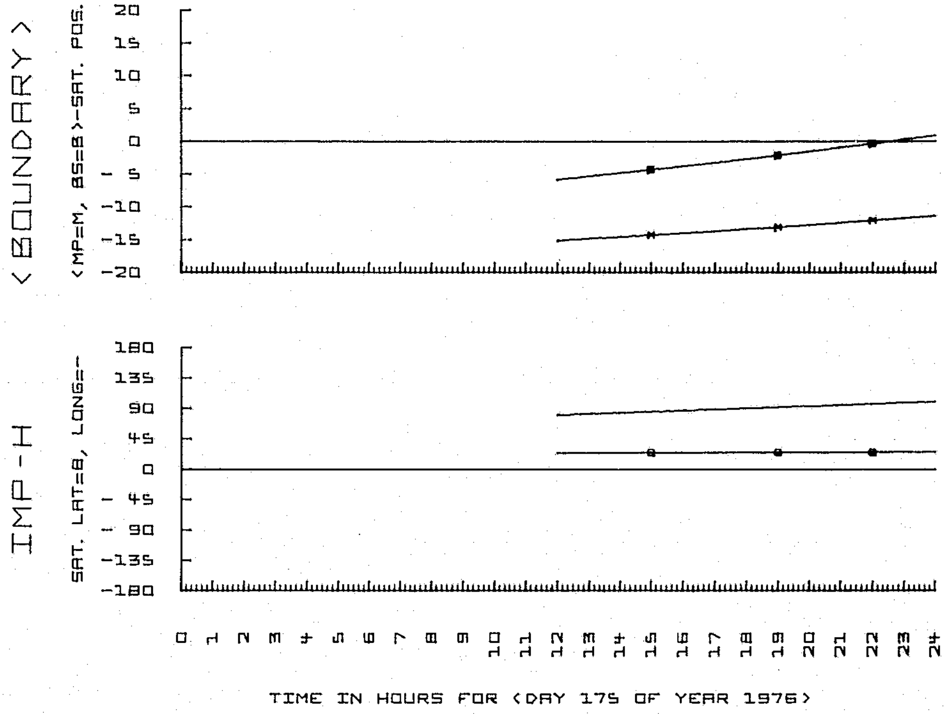


Figure 68. Time Period 10

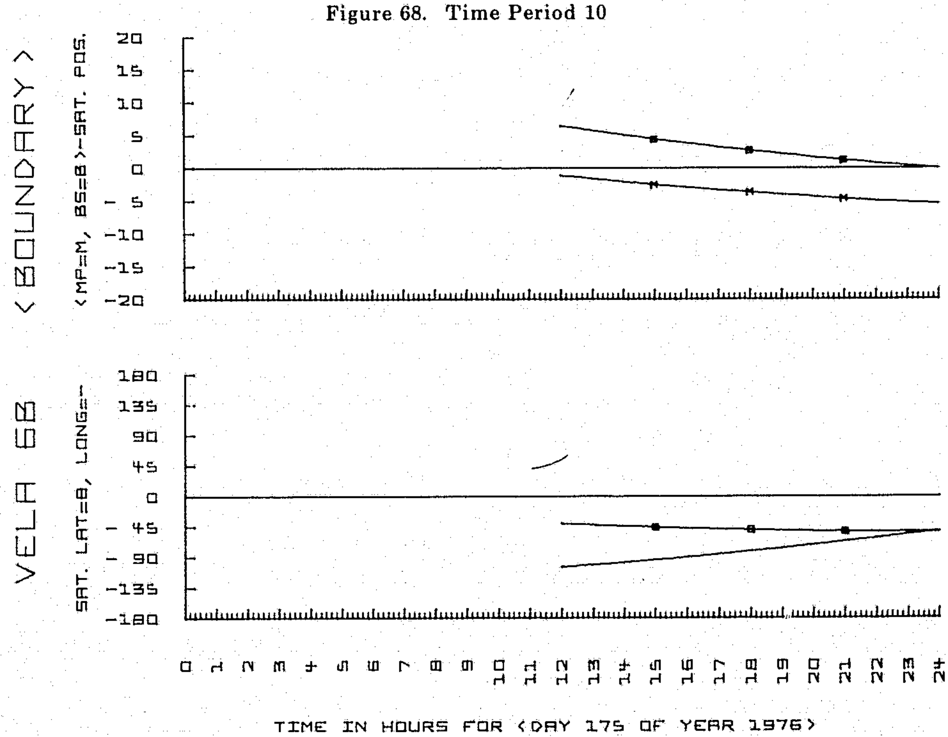


Figure 69. Time Period 10

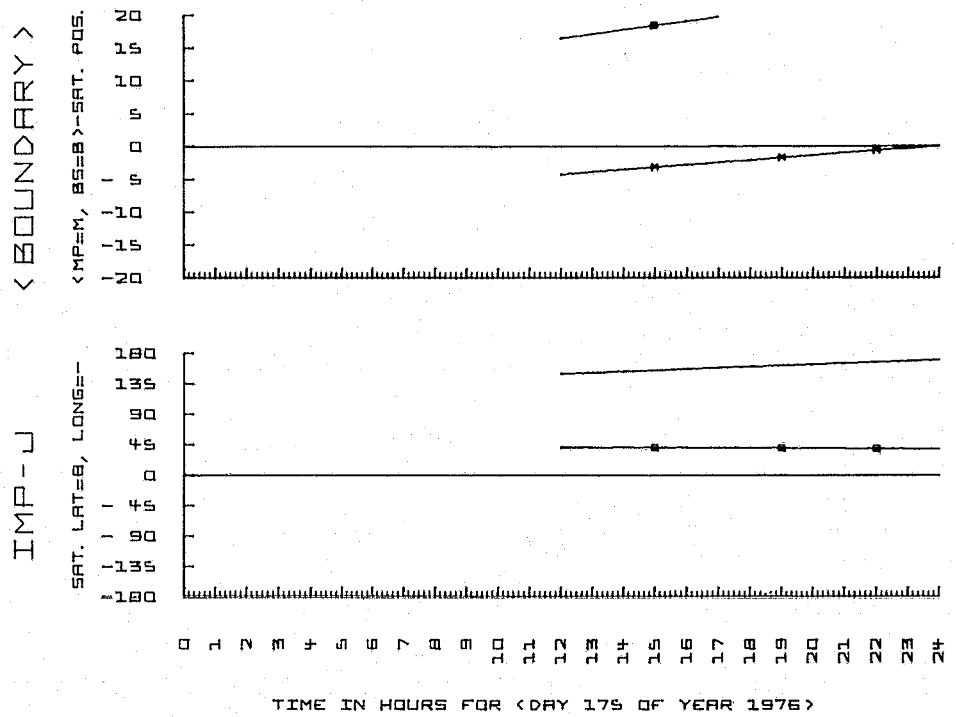


Figure 70. Time Period 10

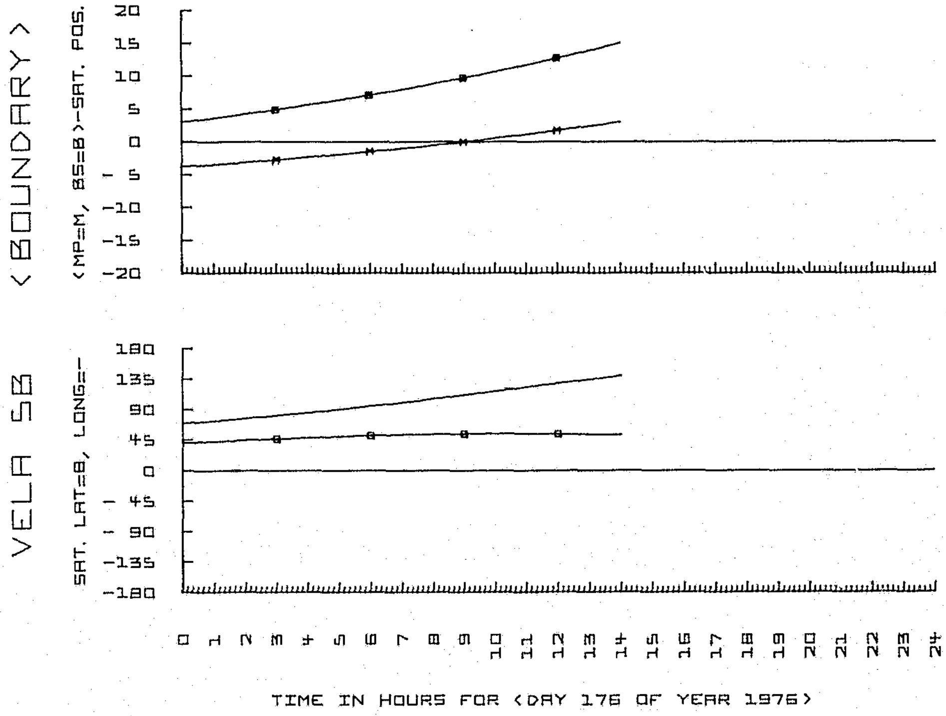


Figure 71. Time Period 10

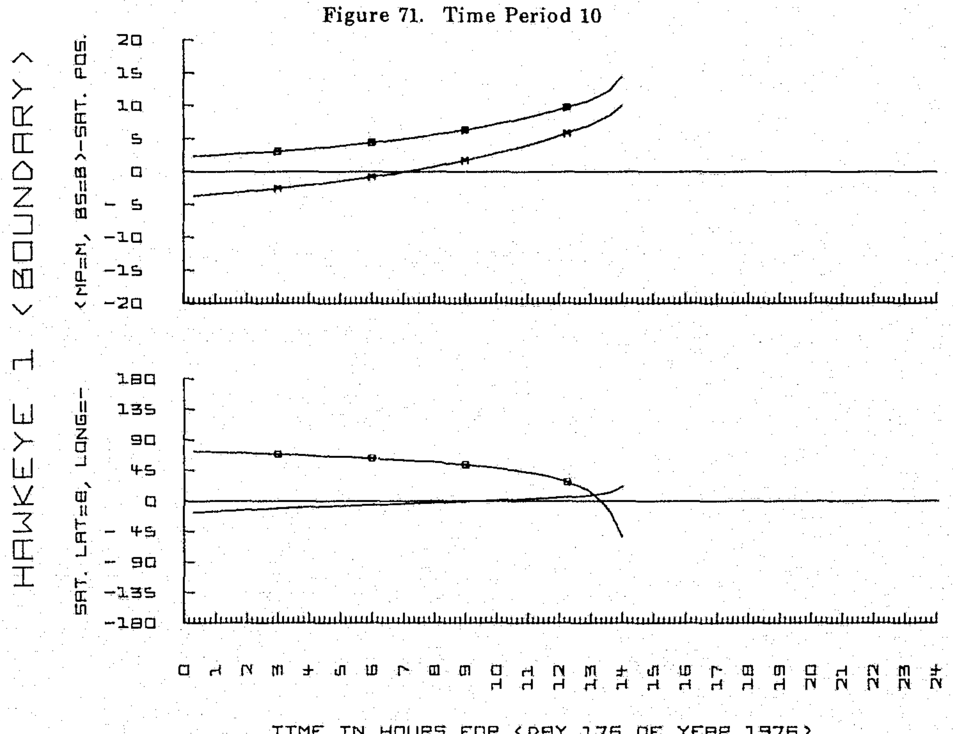


Figure 72. Time Period 10

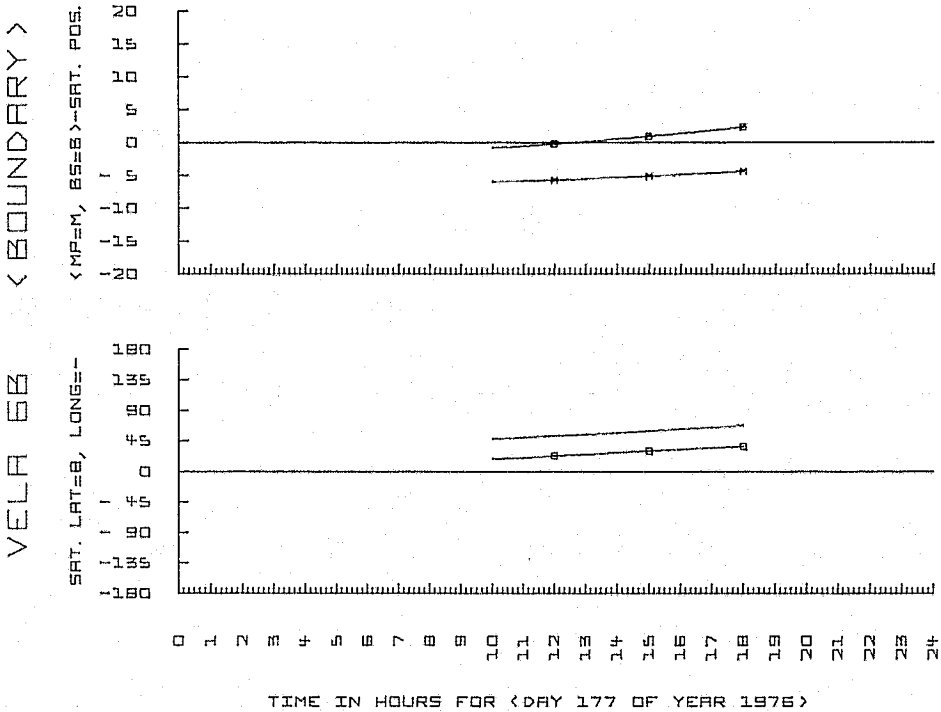


Figure 73. Time Period 10

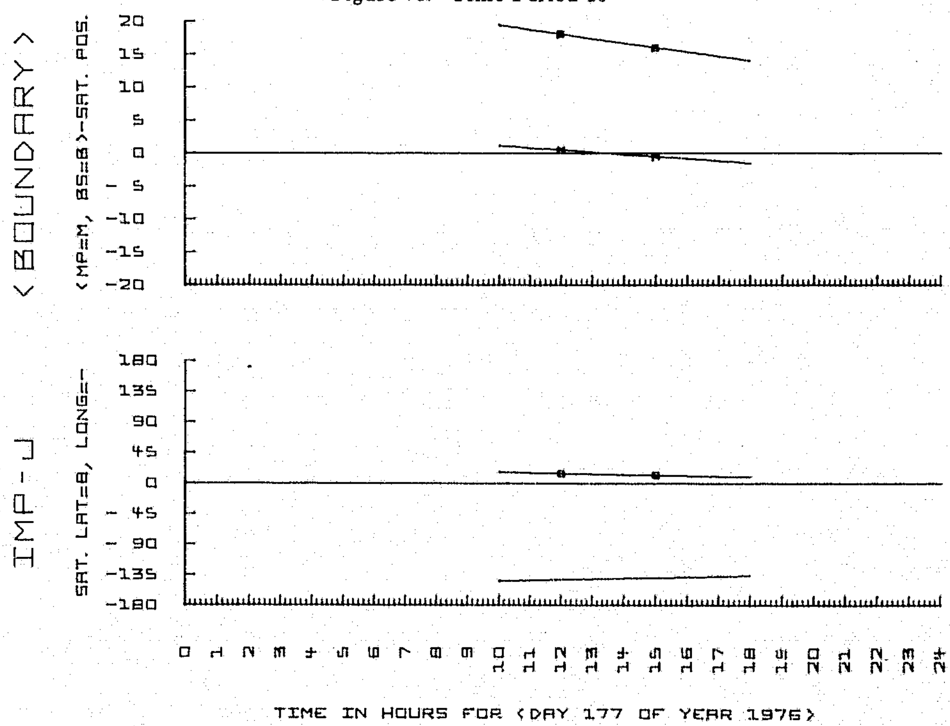


Figure 74. Time Period 10

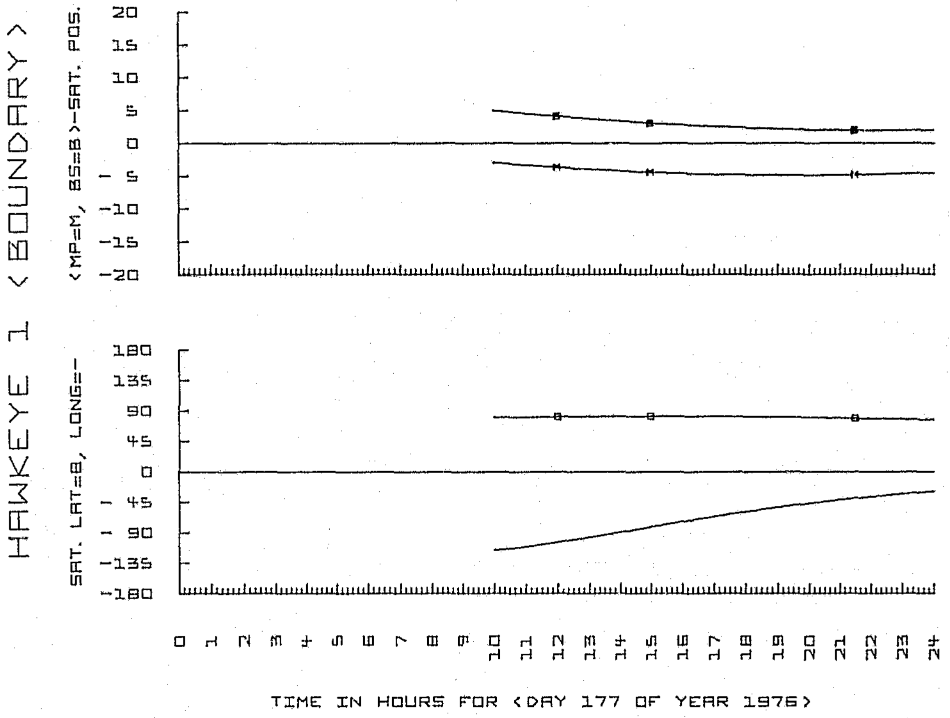


Figure 75. Time Period 10

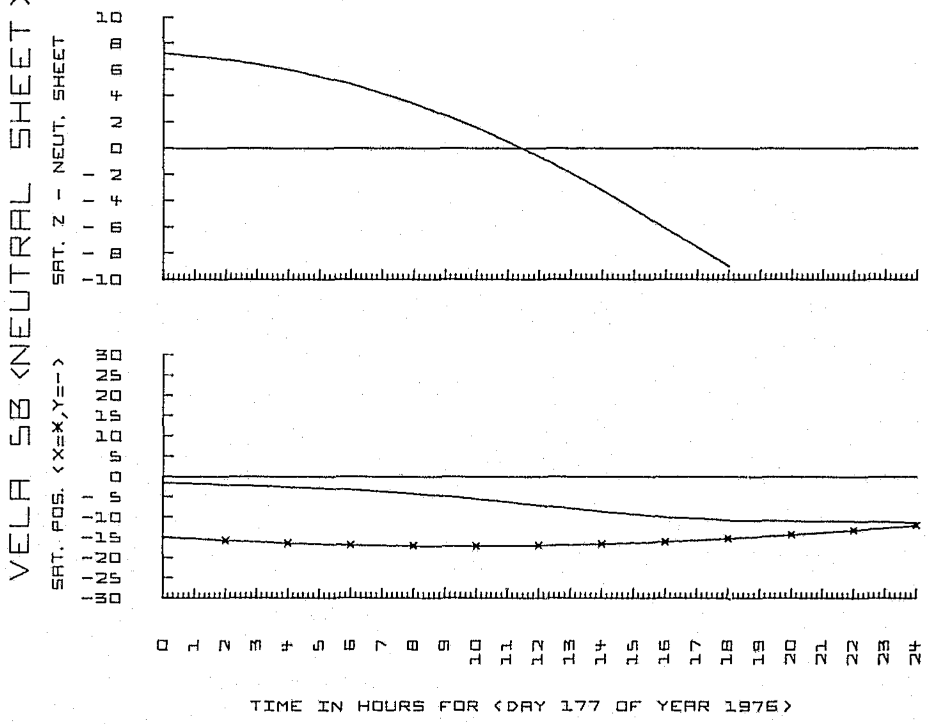


Figure 76. Time Period 10

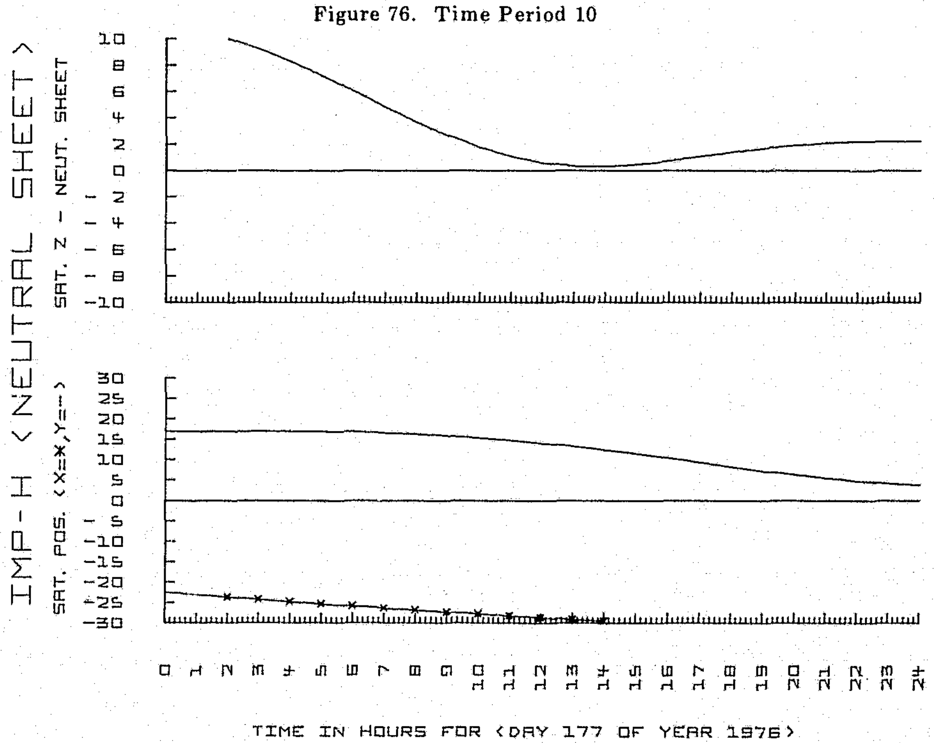


Figure 77. Time Period 10

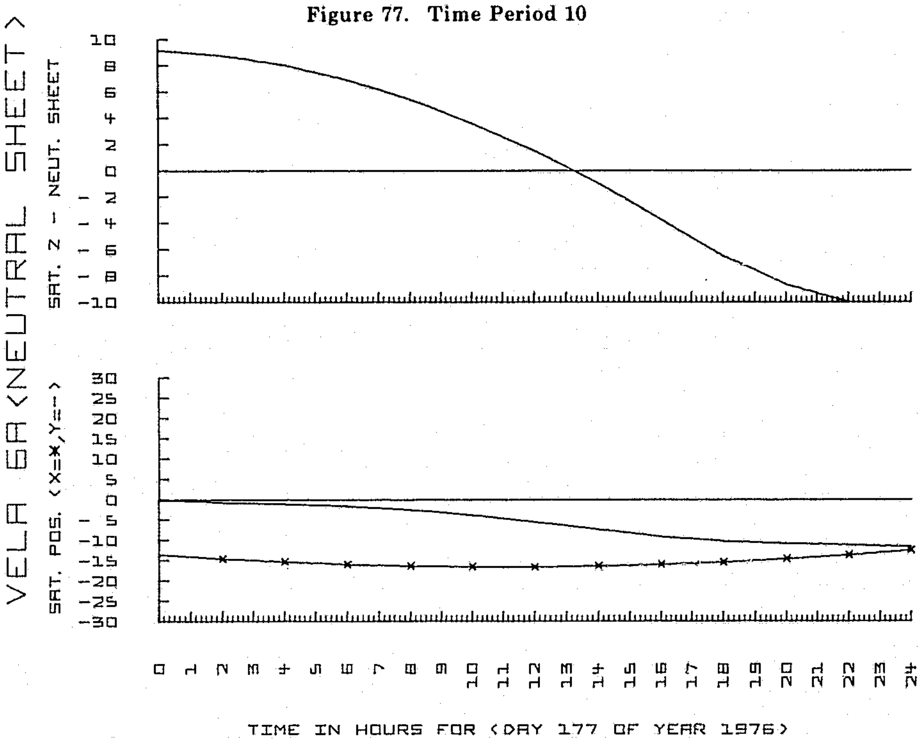


Figure 78. Time Period 10

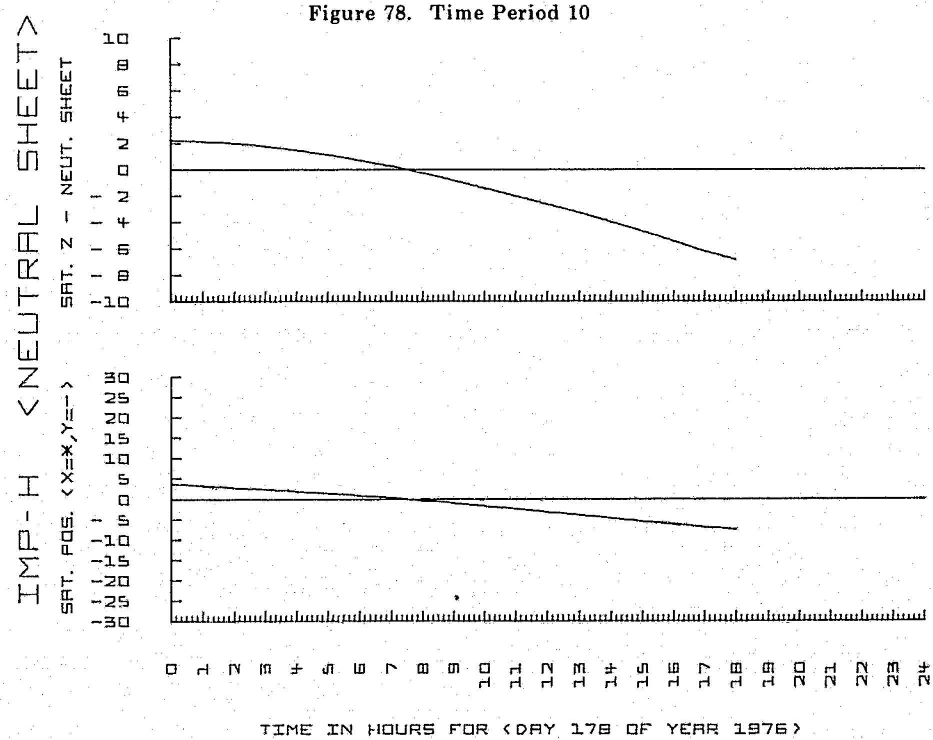
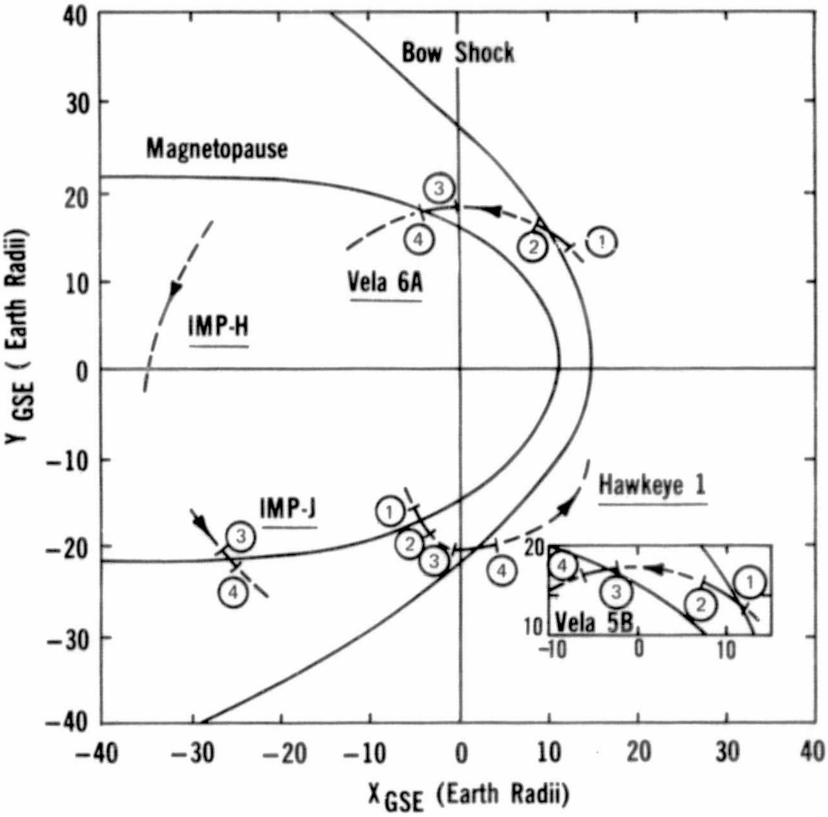


Figure 79

TIME PERIOD 11: 1976 Day 189/14h - 190/14h



Code	Time	Vela 5B	Vela 6A	IMP-J	IMP-H	Hawkeye 1
1	189/20 h	I	I	MT	MT	NM
2	190/2 h	DS	DS	MT	MT	NS
3	190/9 h	NS	NS	MT	MT	DS
4	190/13 h	NM	NM	NS	MT	DS

Bow Shock Crossings

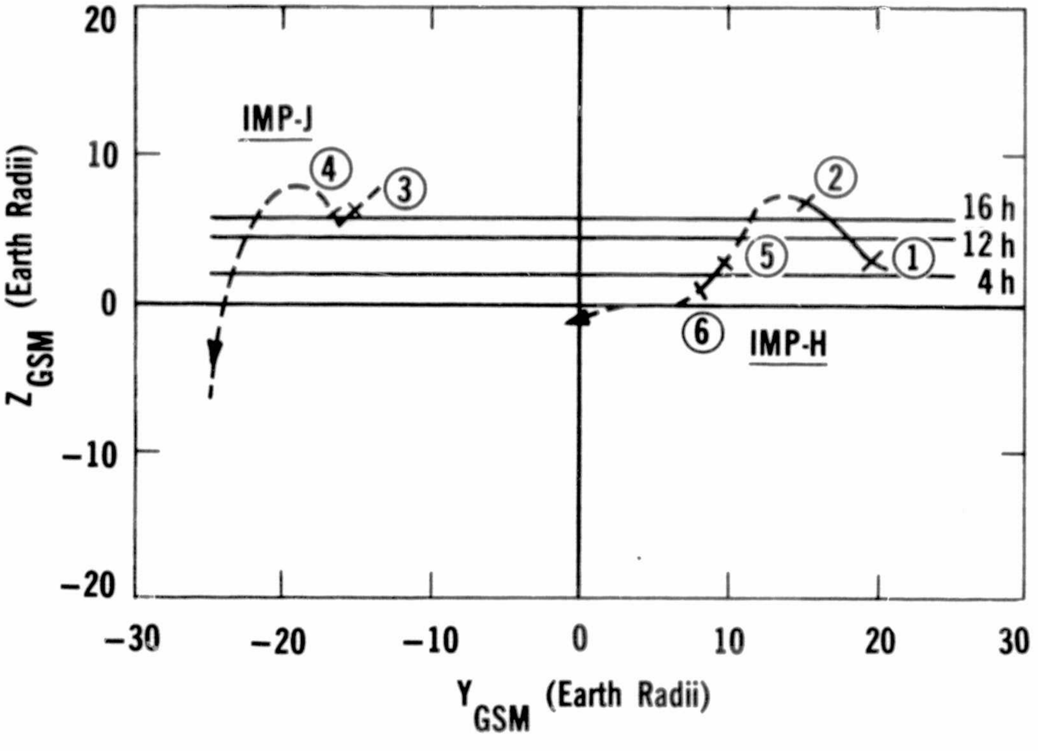
Time	Sat.	Direct.	Lat. (deg)
189/20.5 h	Vela 5B	In	37.5
190/0 h	Vela 6A	In	36.8
190/14 h	Hawkeye 1	Close Approach	81.7

Magnetopause Crossings

Time	Sat.	Direct.	Lat. (deg)
190/0.5 h	Hawkeye 1	Out	75.5
190/10.5 h	Vela 5B	In	53.4
190/12 h	IMP-J	Out	1.25
190/13 h	Vela 6A	In	53.2

Figure 80

TIME PERIOD 11: 1976 Day 189/14h - 190/14h



Code	Time	IMP-H Alt. (E.R.)	IMP-J Alt. (E.R.)
1	189/14 h	30.9	33.2
2	189/19.5 h	31.3	33.0
3	189/22 h	31.5	33.1
4	189/24 h	31.8	32.8
5	190/3 h	32.1	32.8
6	190/8 h	32.7	32.7

Figure 81. Time Period 11

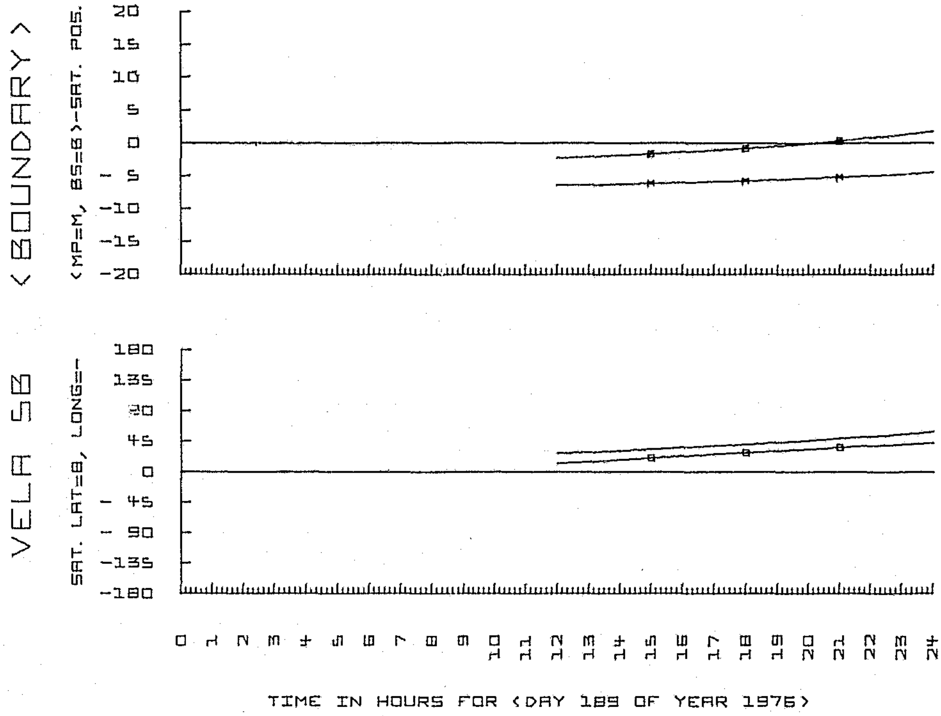


Figure 82. Time Period 11

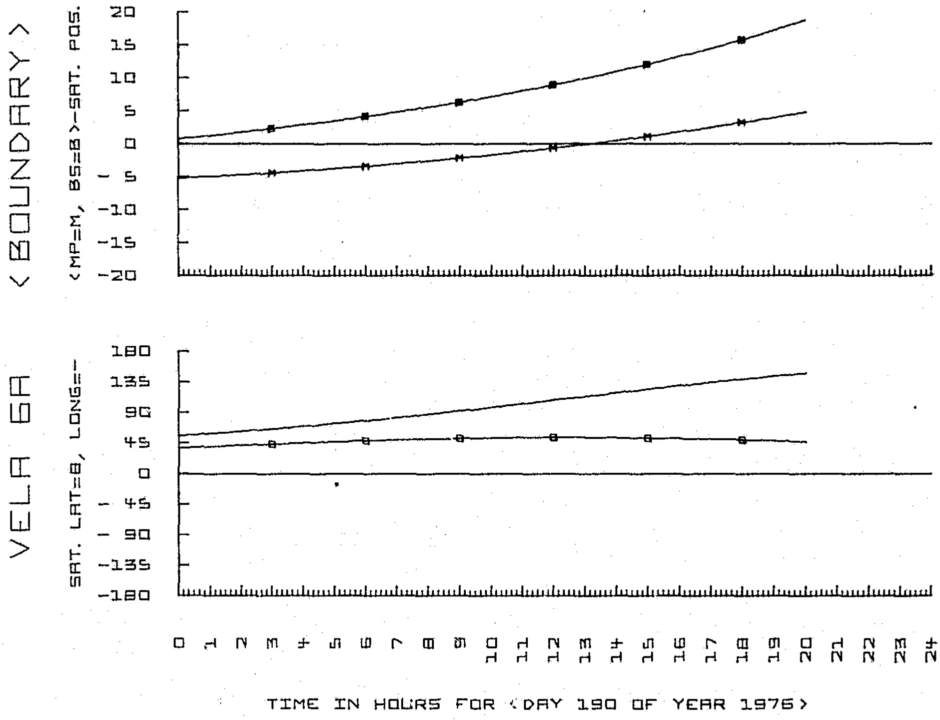


Figure 83. Time Period 11

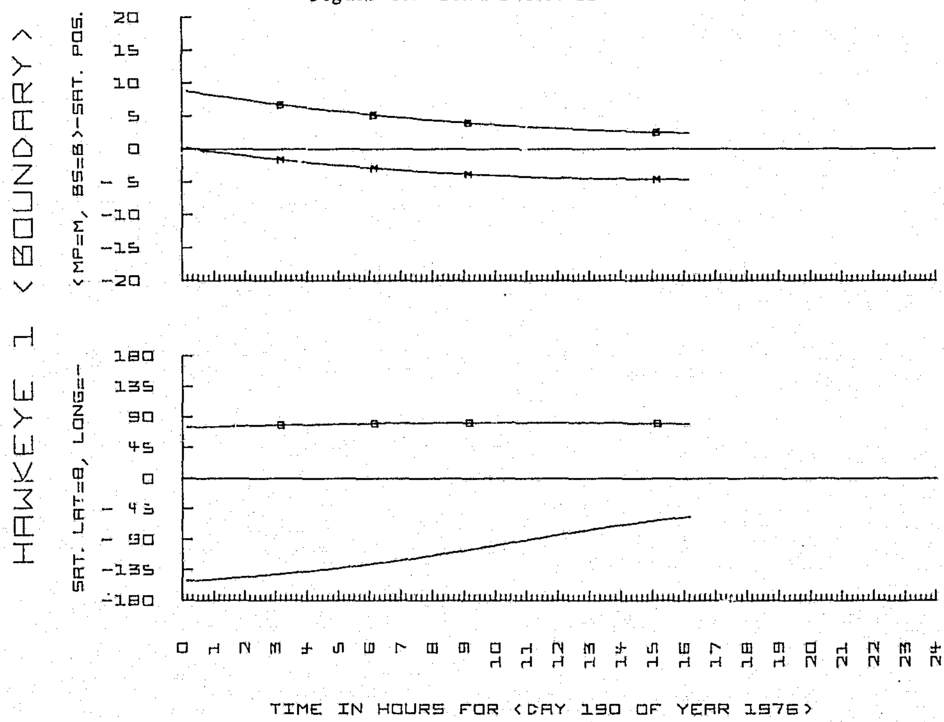


Figure 84. Time Period 11

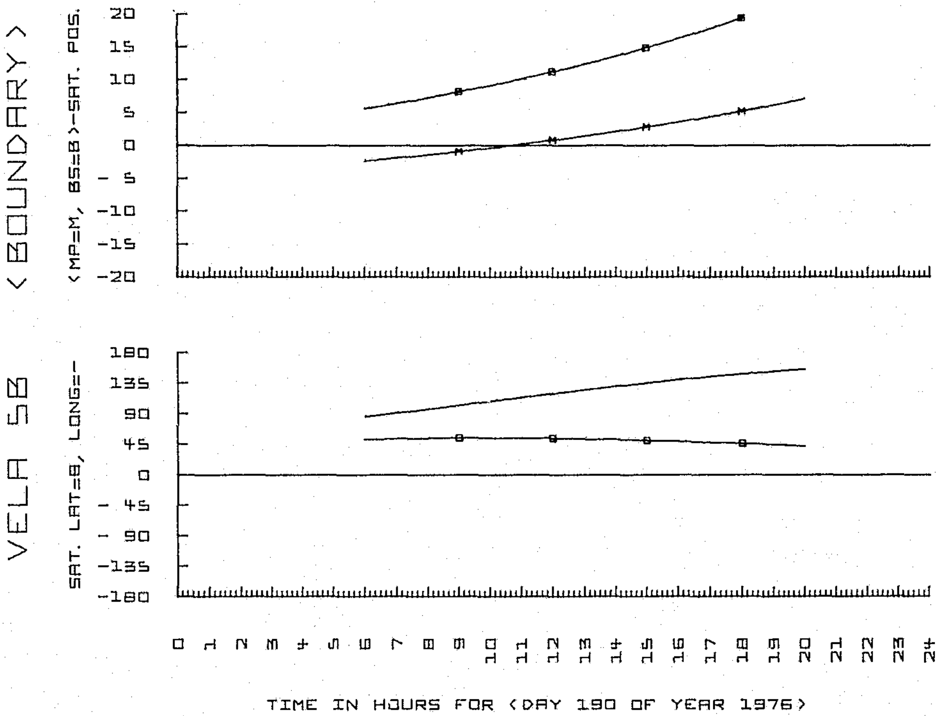


Figure 85. Time Period 11

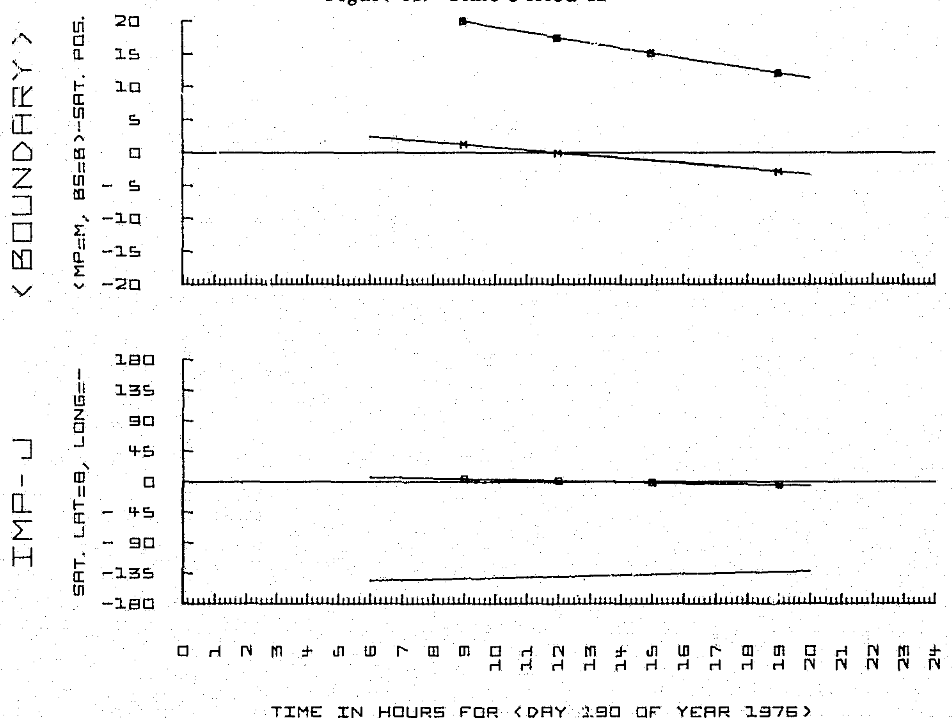


Figure 86. Time Period 11

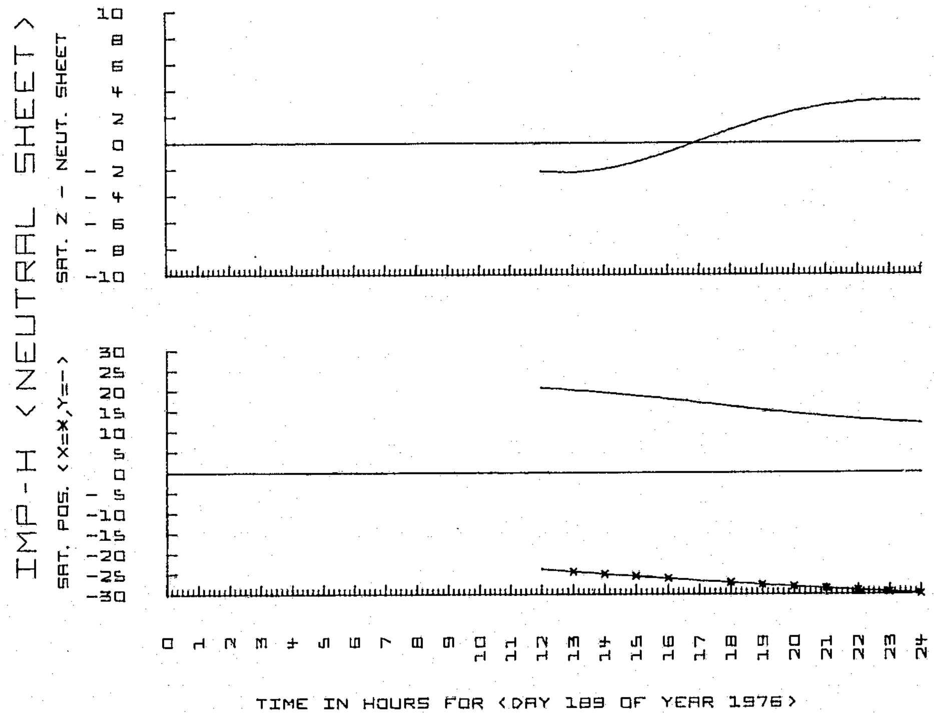


Figure 87. Time Period 11

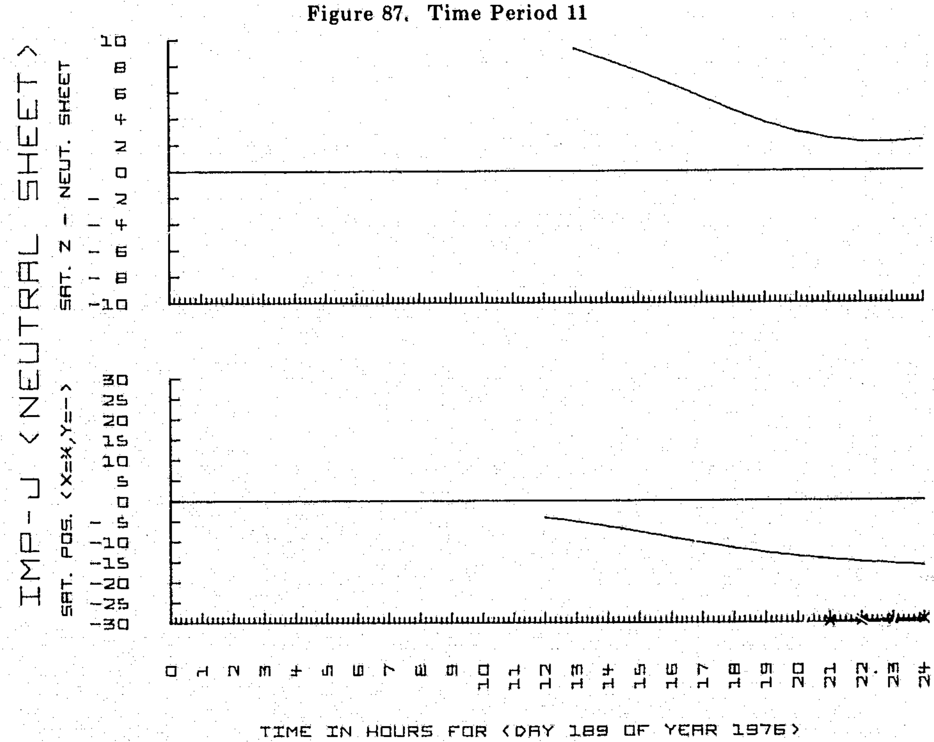


Figure 88. Time Period 11

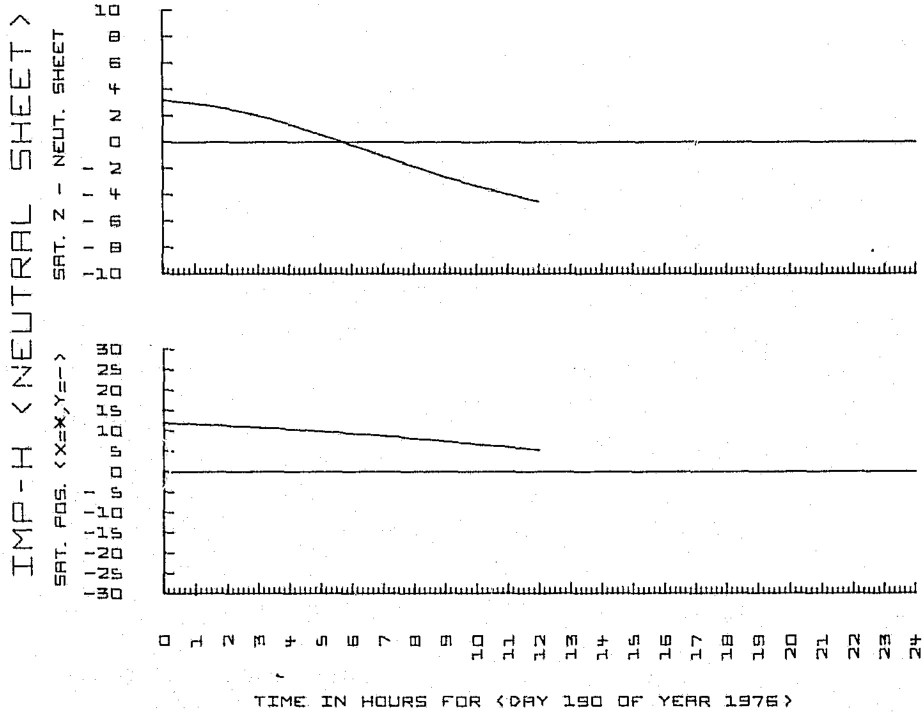


Figure 89. Time Period 12: 1976 Day 192/3h-Day 192/4h

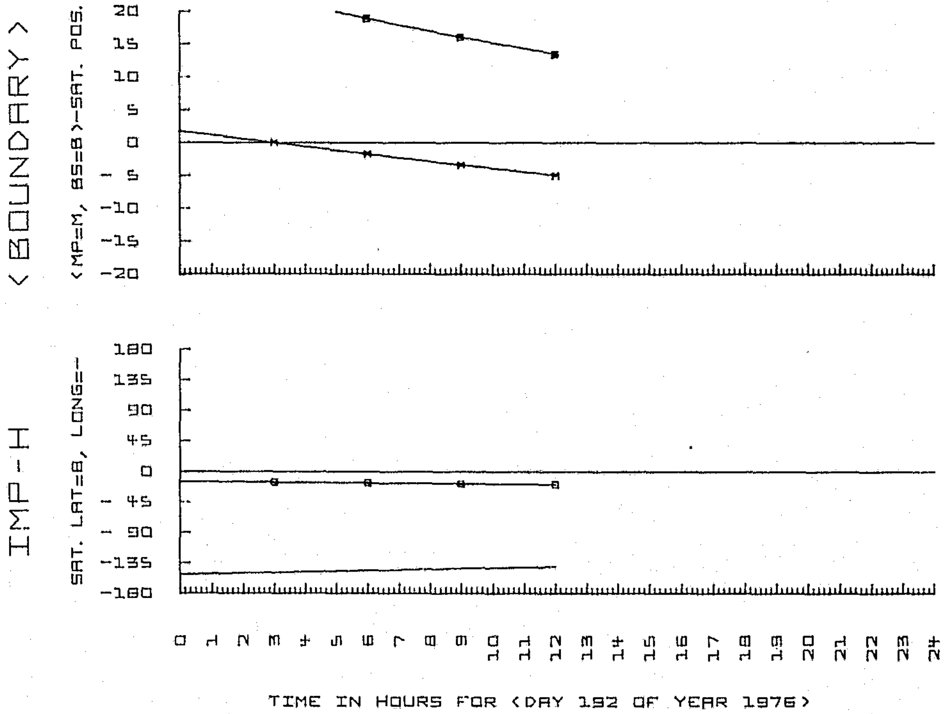


Figure 90. Time Period 12: 1976 Day 192/3h-Day 192/4h

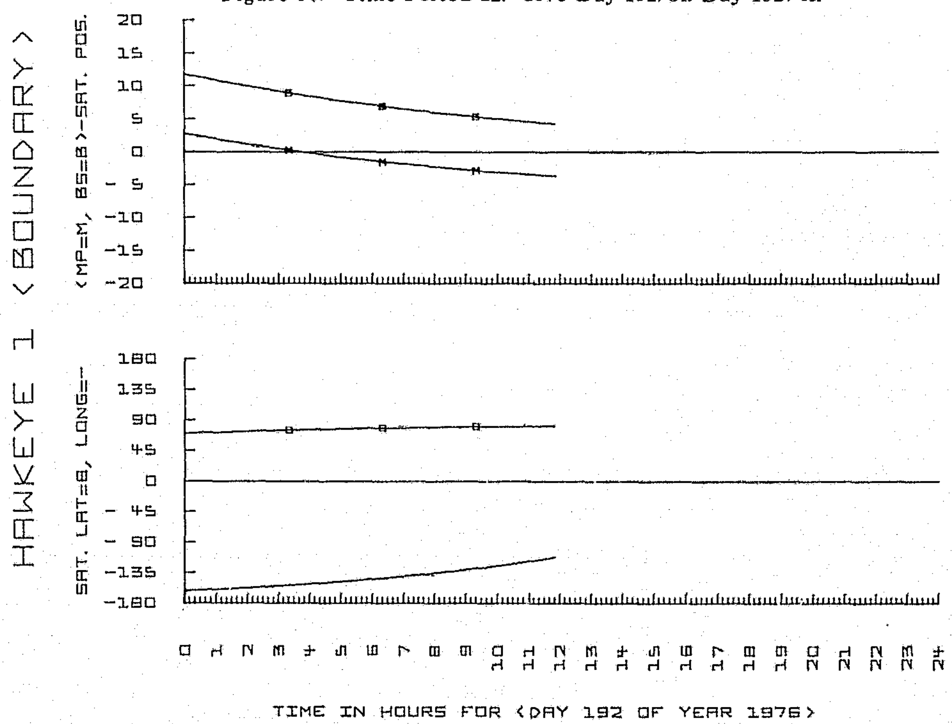


Figure 91. Time Period 13: 1976 Day 204/12h-Day 204/14h

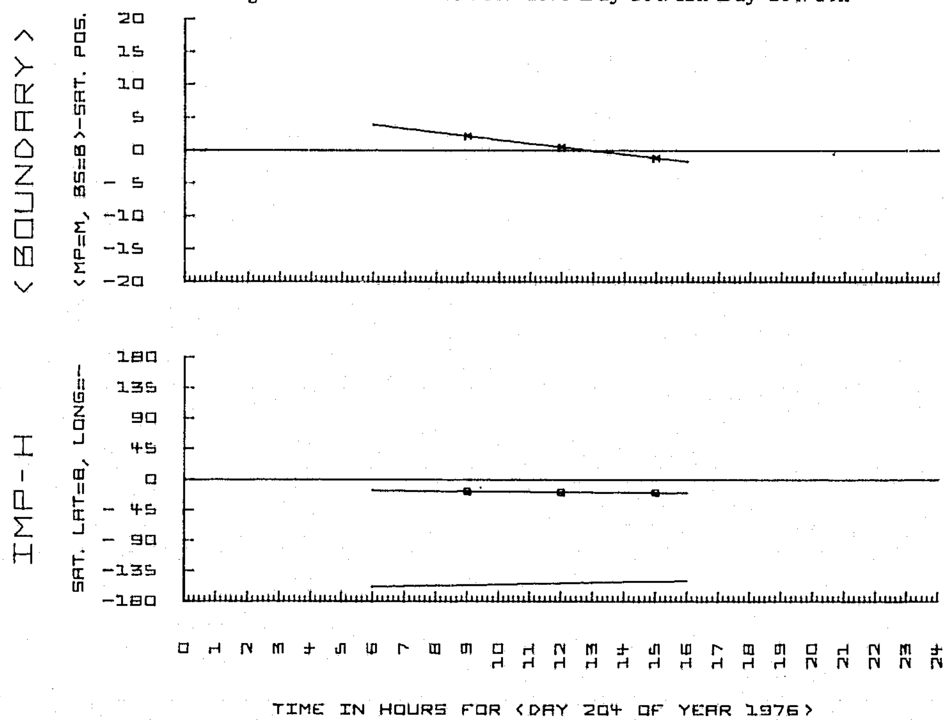


Figure 92. Time Period 13: 1976 Day 204/12h-Day 204/14h

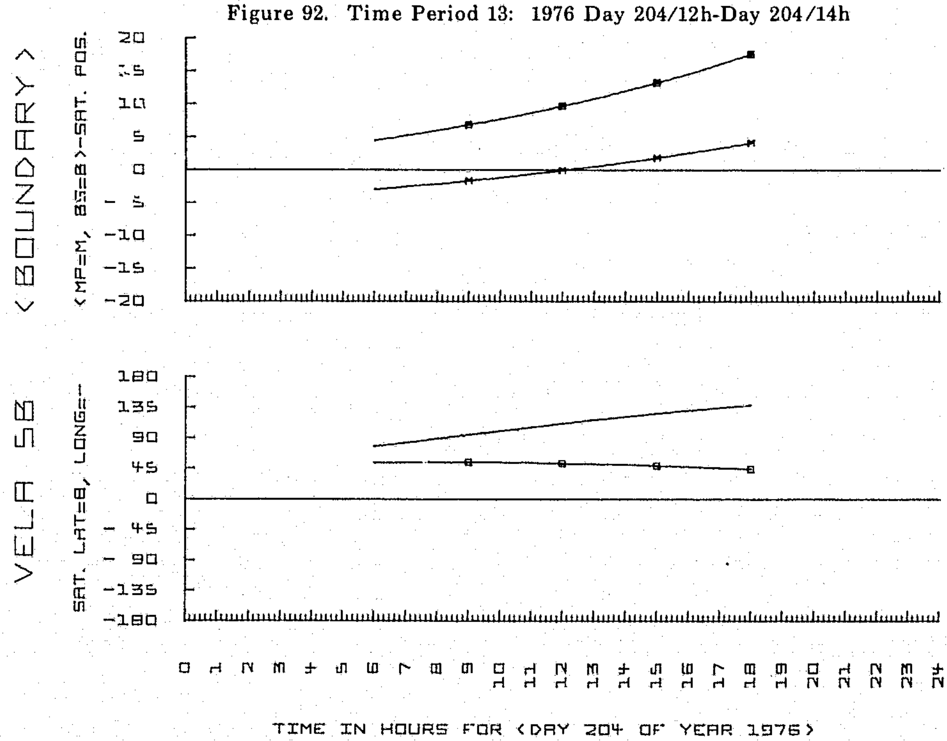


Figure 93. Time Period 13: 1976 Day 204/12h—Day 204/14h

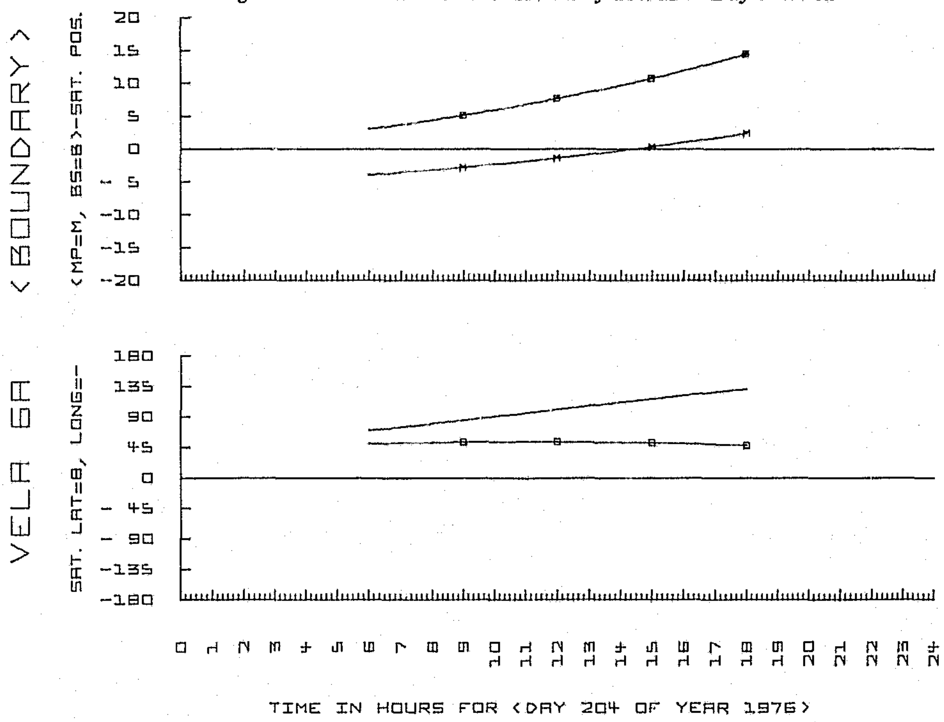
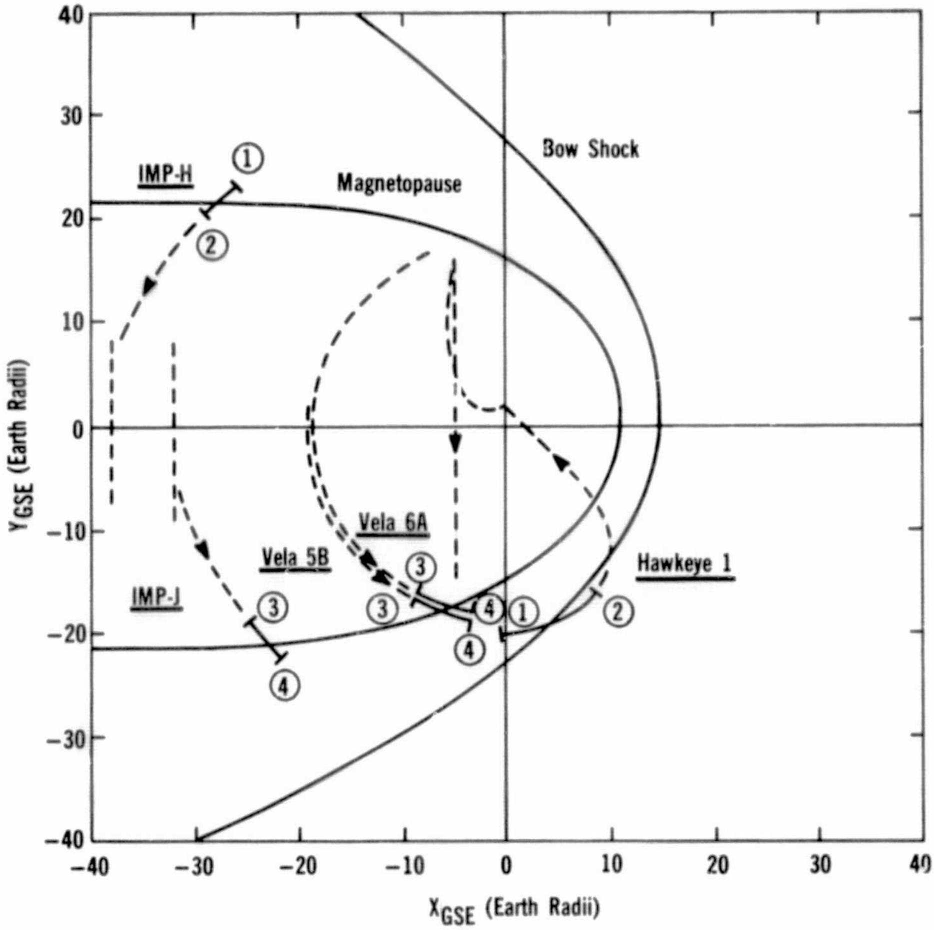


Figure 94

TIME PERIOD 14:1976 Day 214/2h - 215/24h



Code	Time	Vela 5B	Vela 6A	IMP-H	IMP-J	Hawkeye 1
1	214/2h	NM	NM	NS	HT	NS
2	214/8h	MT	MT	HT	HT	DS
3	215/18h	NM	NM	HT	HT	NS
4	215/24h	NS	NS	HT	NS	NS

Bow Shock Crossings

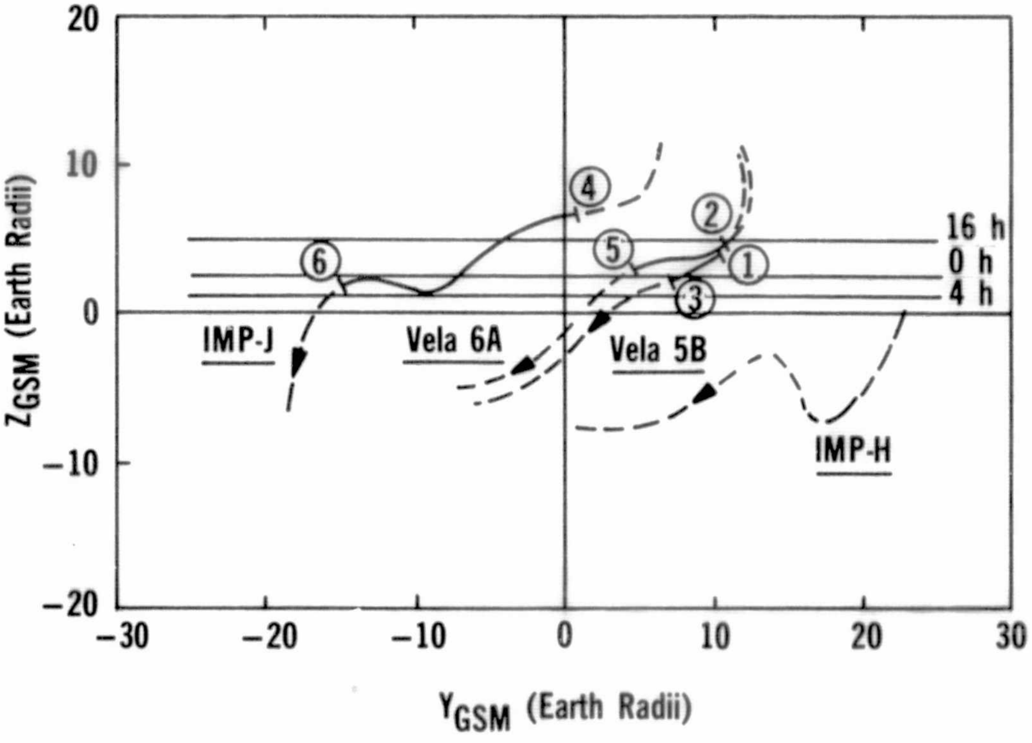
Time	Sat.	Direct.	Lat. (deg)
214/5h	Hawkeye 1	Close Approach	79.4

Magnetopause Crossings

Time	Sat.	Direct.	Lat. (deg)
214/6 h	IMP-H	In	5.6
215/21h	IMP-J	Out	−18.0
215/22h	Vela 5B	Out	−50.5
215/22h	Vela 6A	Out	−48.7

Figure 95

TIME PERIOD 14: 1976 Day 214/2h - 215/24h



Code	Time	Vela 6A Alt (E.R.)	Vela 5B Alt (E.R.)	IMP-J Alt (E.R.)
1	214/9h	17.4	17.6	32.0
2	214/10h	17.4	17.6	31.9
3	214/14h	17.5	17.7	31.7
4	214/15h	17.5	17.8	31.6
5	214/18.5h	17.5	17.9	31.5
6	215/12.5 h	17.6	18.1	30.6

Figure 96. Time Period 14

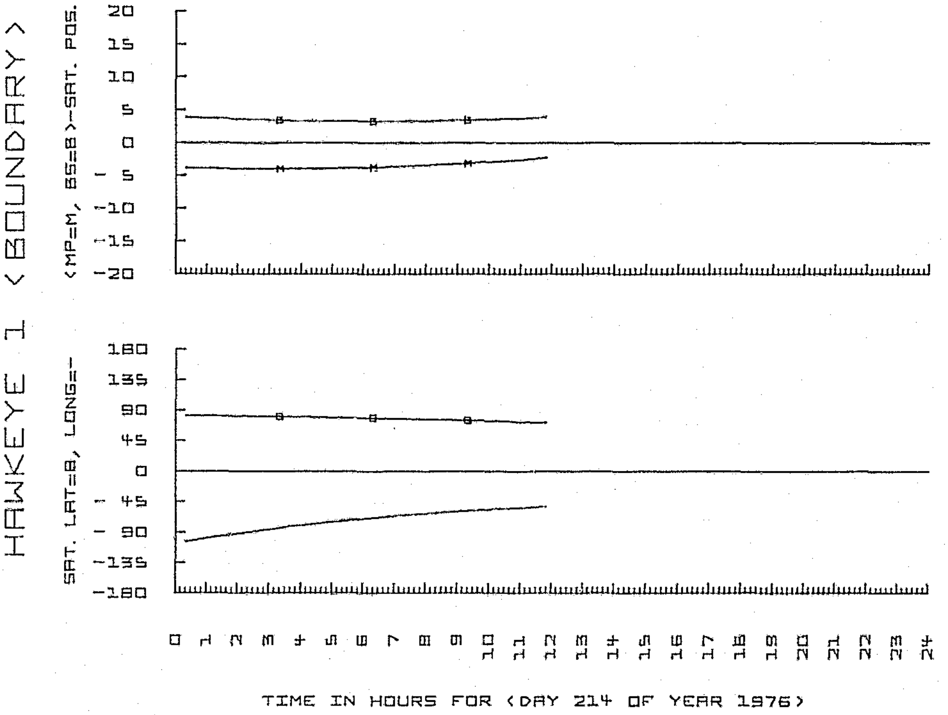


Figure 97. Time Period 14

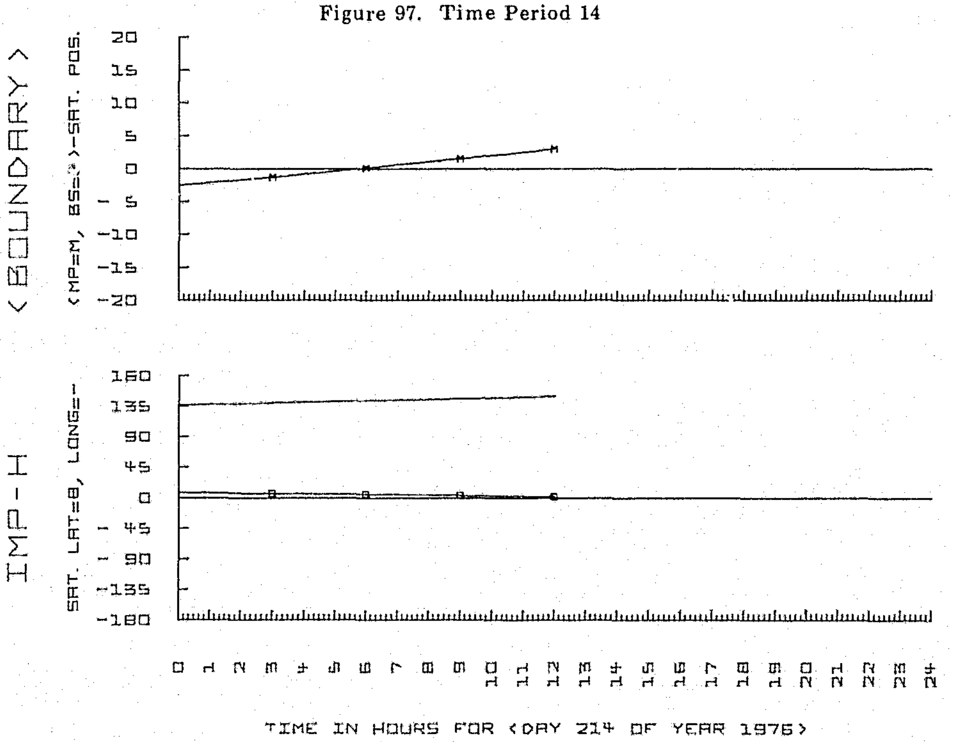


Figure 98. Time Period 14

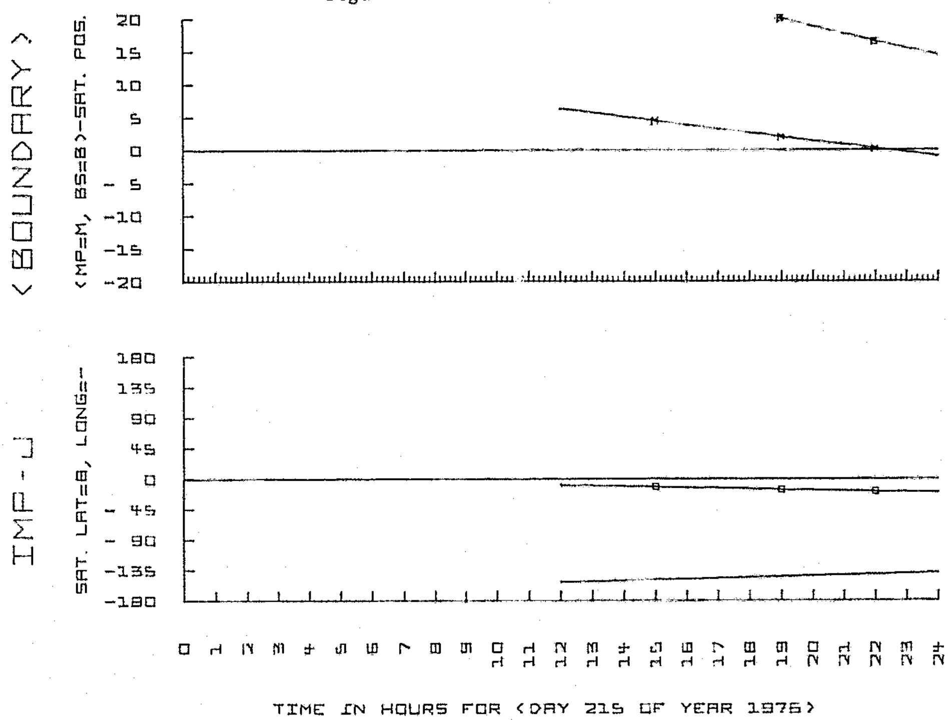


Figure 99. Time Period 14

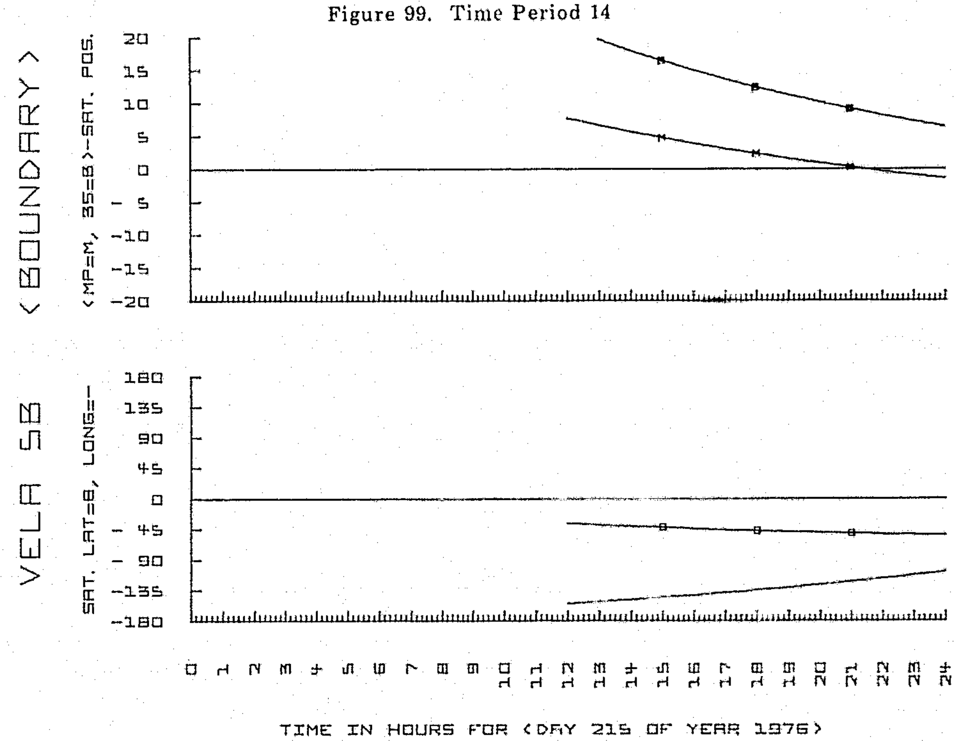


Figure 100. Time Period 14

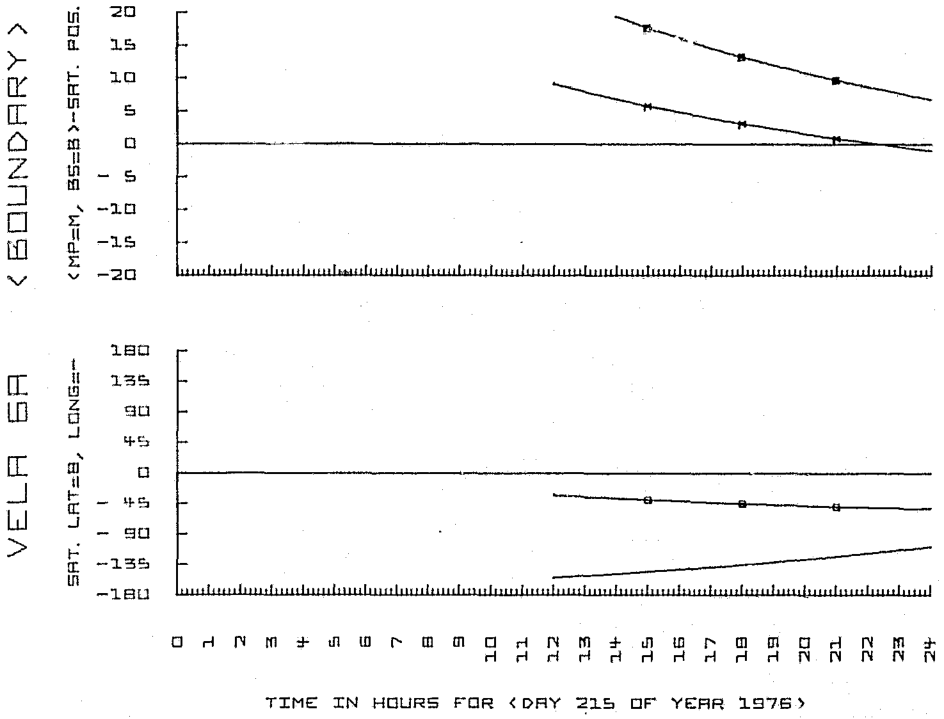


Figure 101. Time Period 14

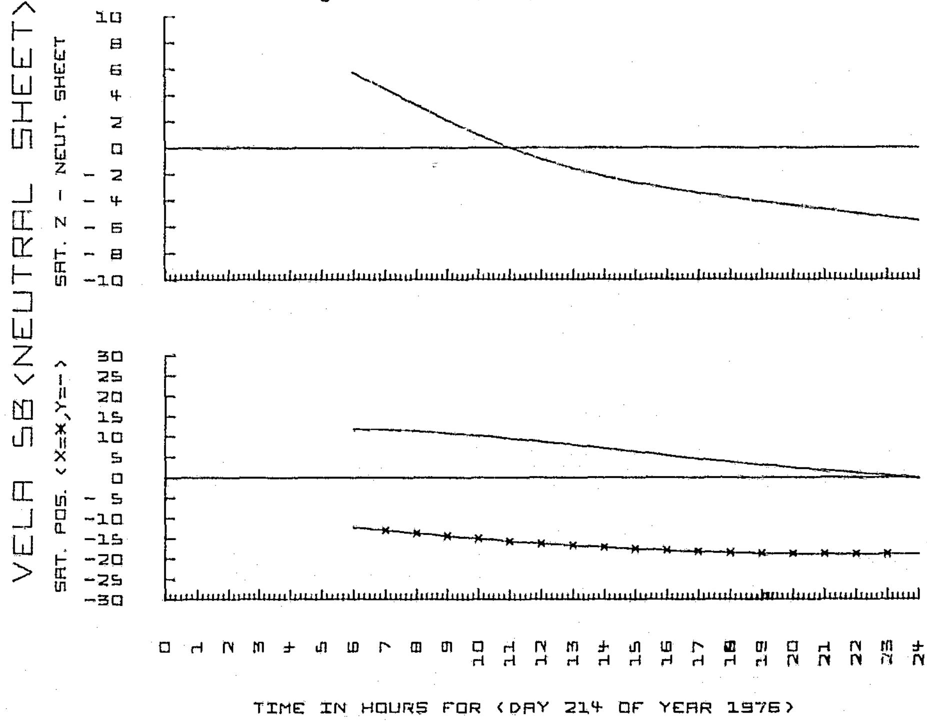


Figure 102. Time Period 14

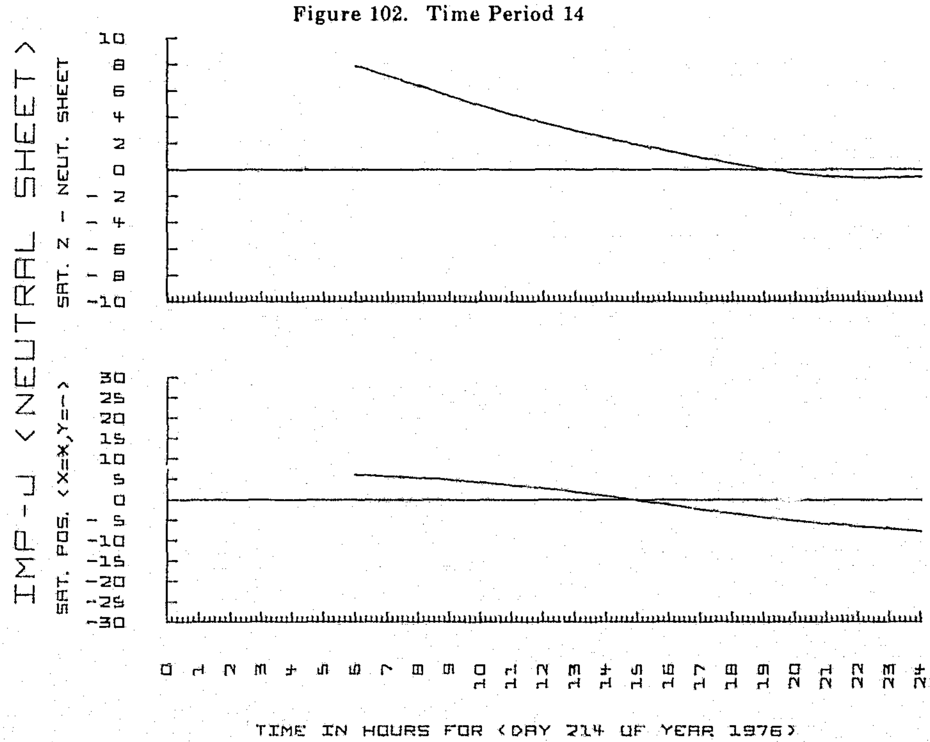


Figure 103. Time Period 14

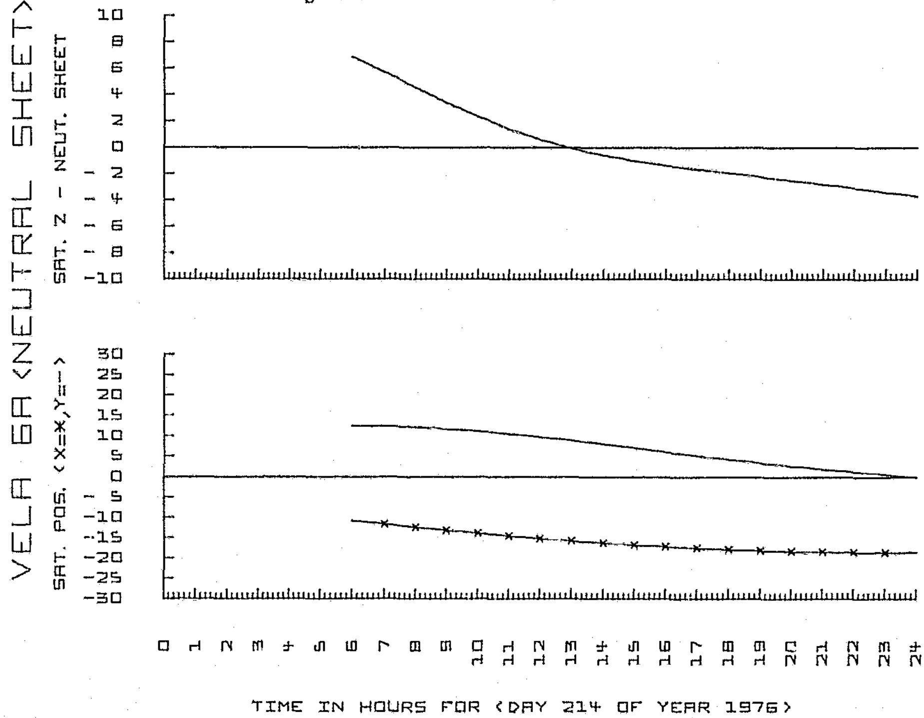


Figure 104. Time Period 14

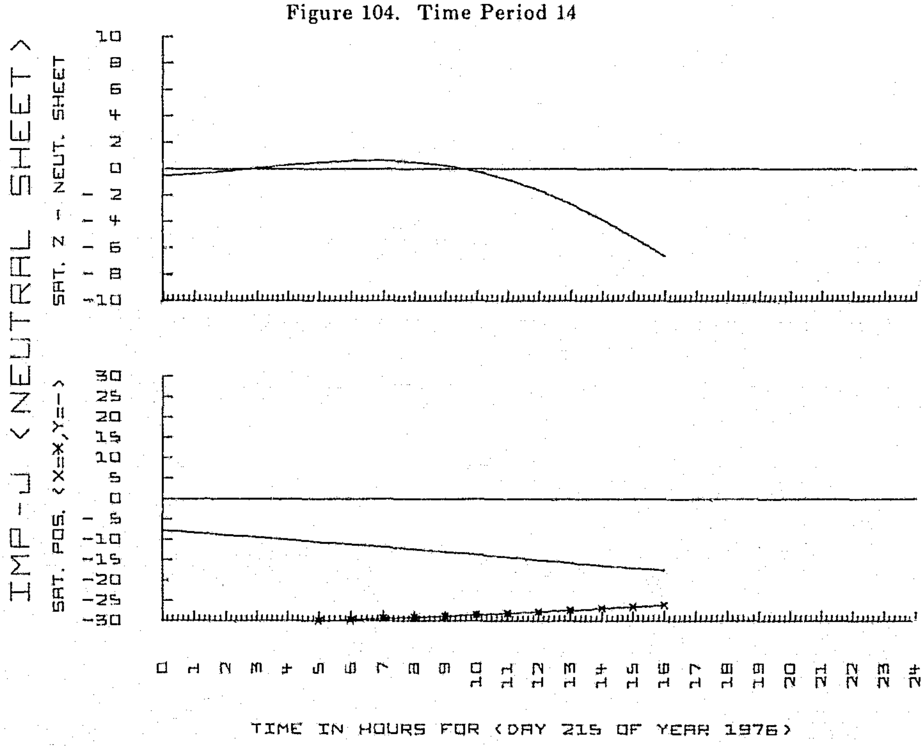


Figure 105. Time Period 15: 1976 Day 331/17h—Day 331/18h

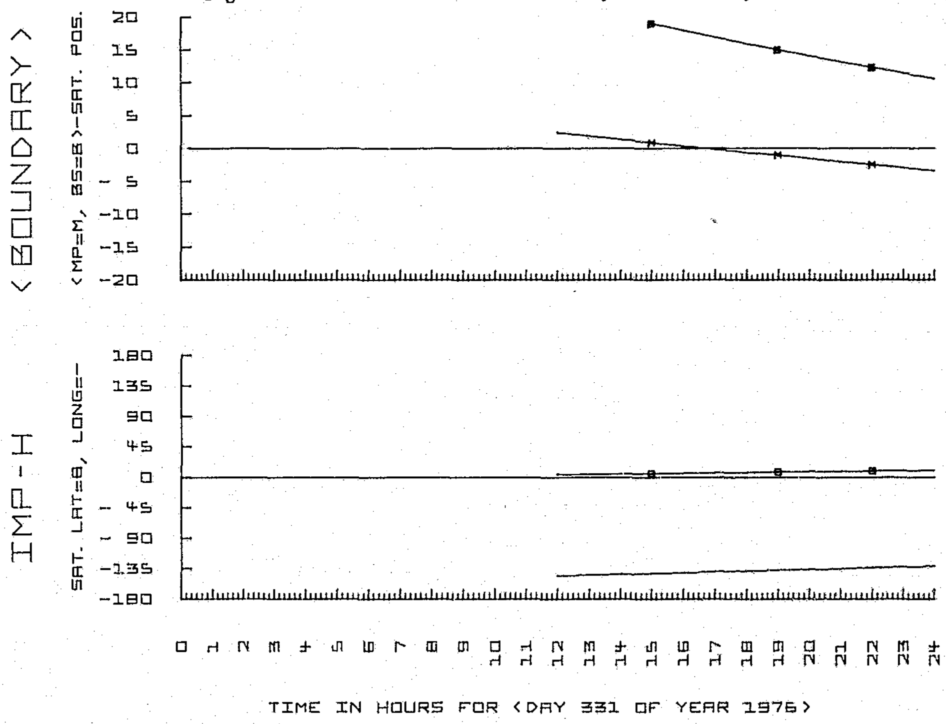
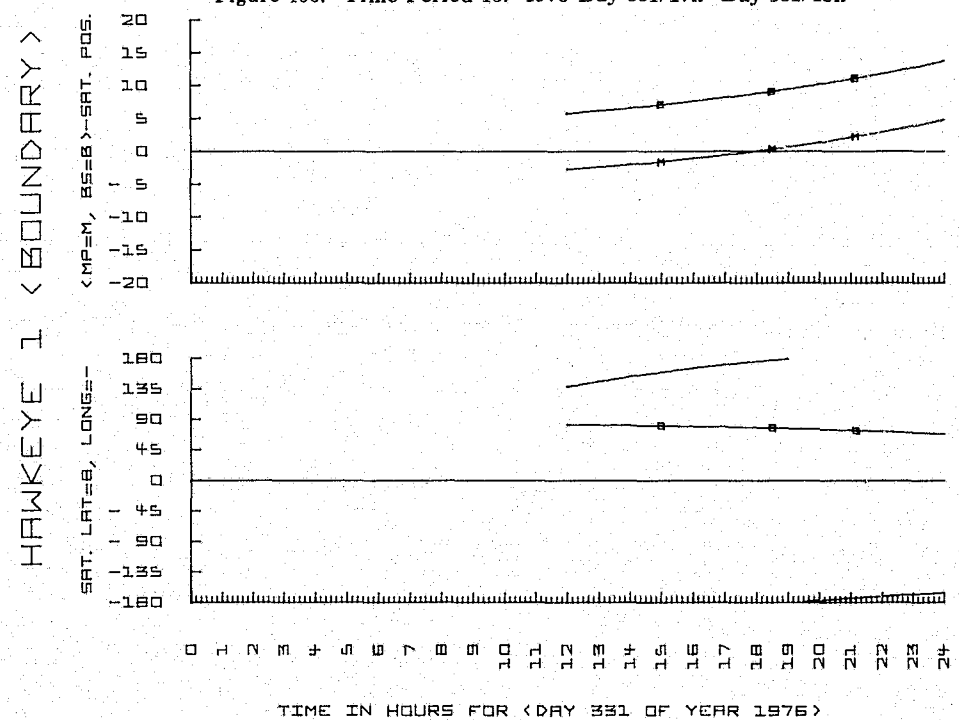


Figure 106. Time Period 15: 1976 Day 331/17h—Day 331/18h



C.2

Figure 107. Time Period 16: 1976 Day 338/13h—Day 338/17h

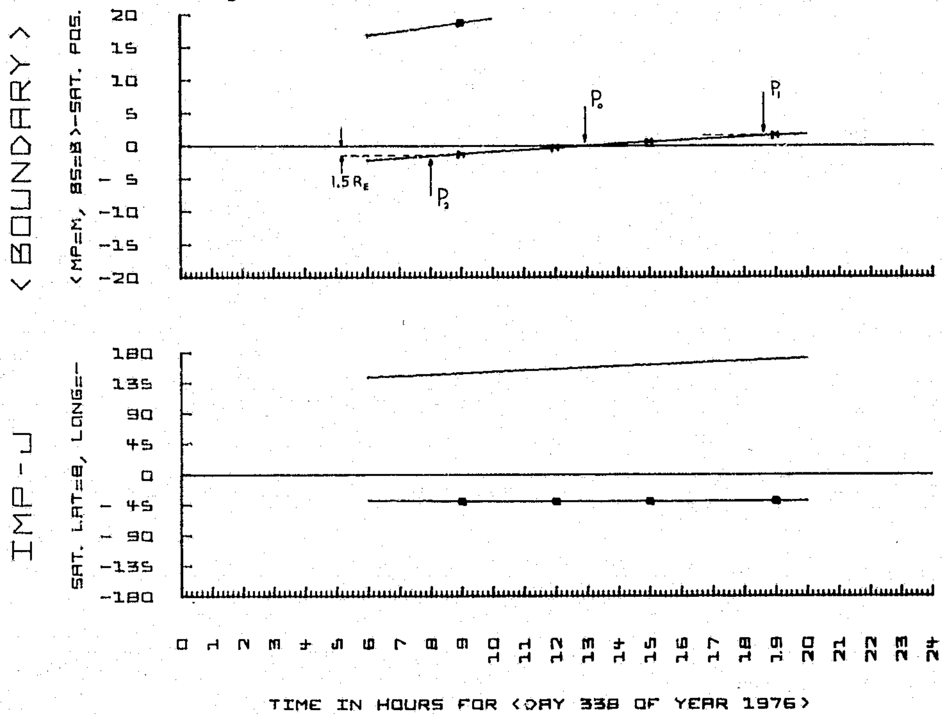


Figure 108. Time Period 16: 1976 Day 338/13h—Day 338/17h

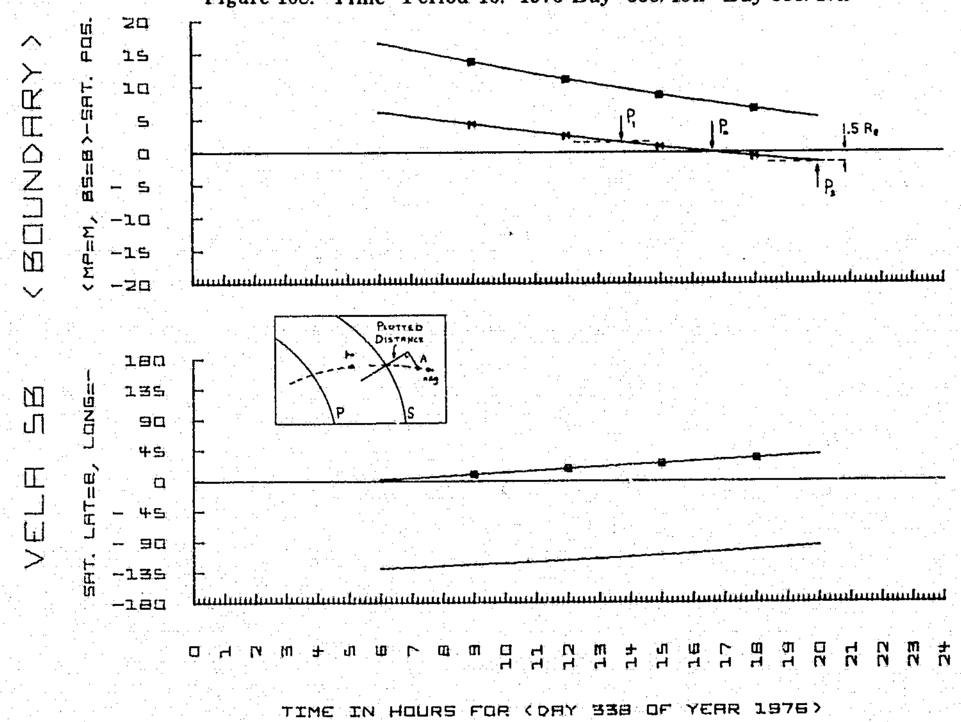


Figure 109. Time Period 16: 1976 Day 338/13h—Day 338/17h

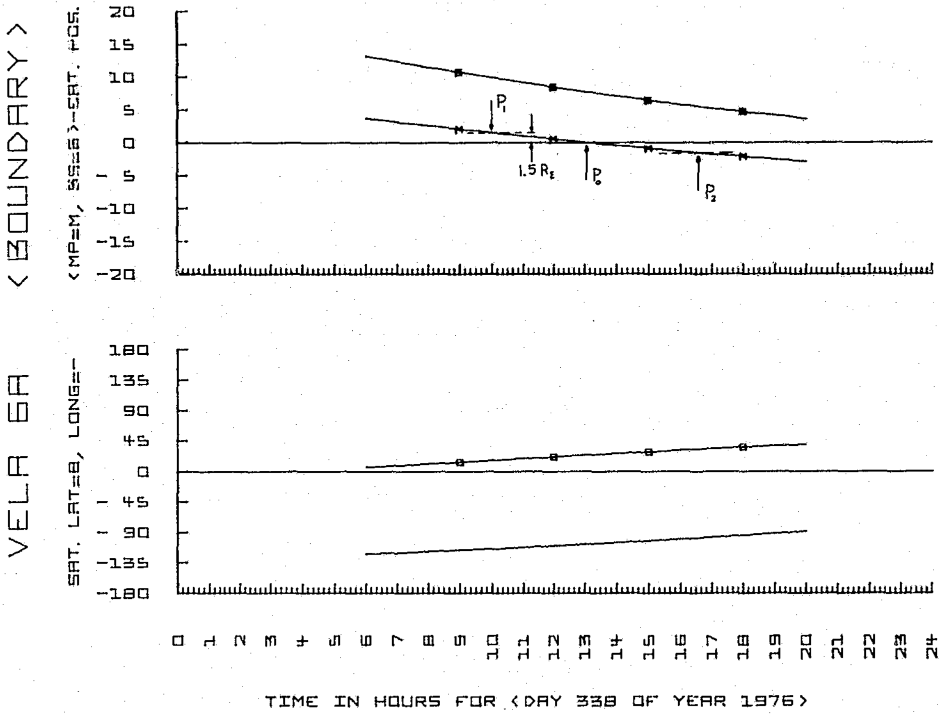


Figure 110. Time Period 16: 1976 Day 338/13h—Day 338/17h

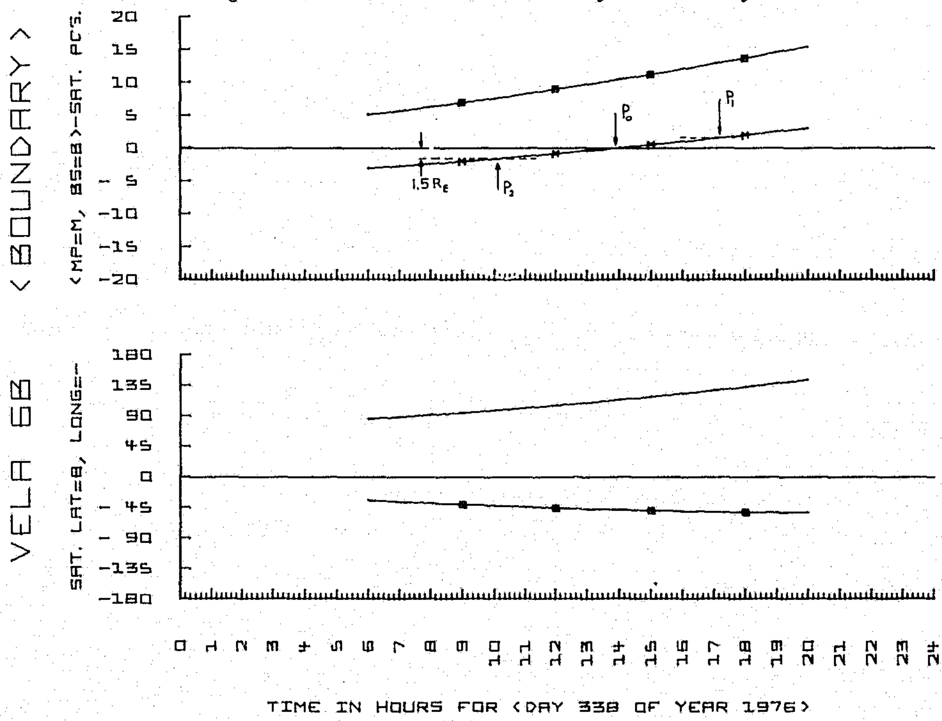
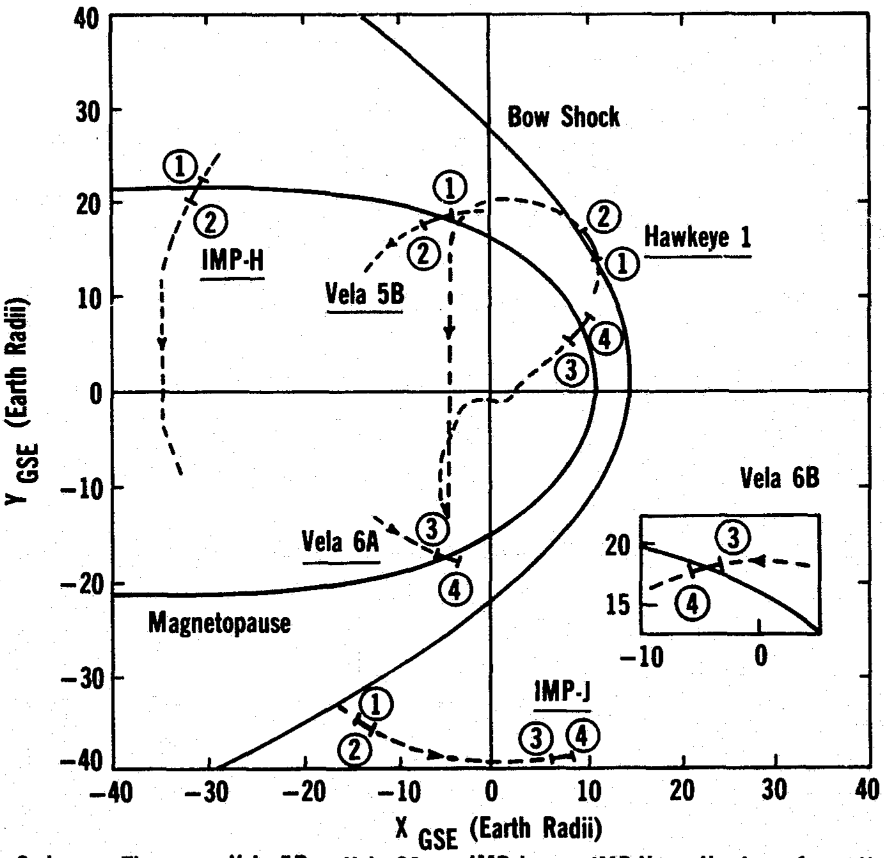


Figure 111

TIME PERIOD 17: 1976 Day 341/12h - 343/8h



Code	Time	Vela 5B	Vela 6A	IMP-J	IMP-H	Hawkeye 1	Vela 6B
1	341/12 h	NS	NM	I	NS	DS	I
2	341/16 h	NM	NM	I	HT	DS	DS
3	343/5 h	NM	NM	I	MT	DM	NS
4	343/8 h	NM	NS	I	HT	DS	NM

Bow Shock Crossings

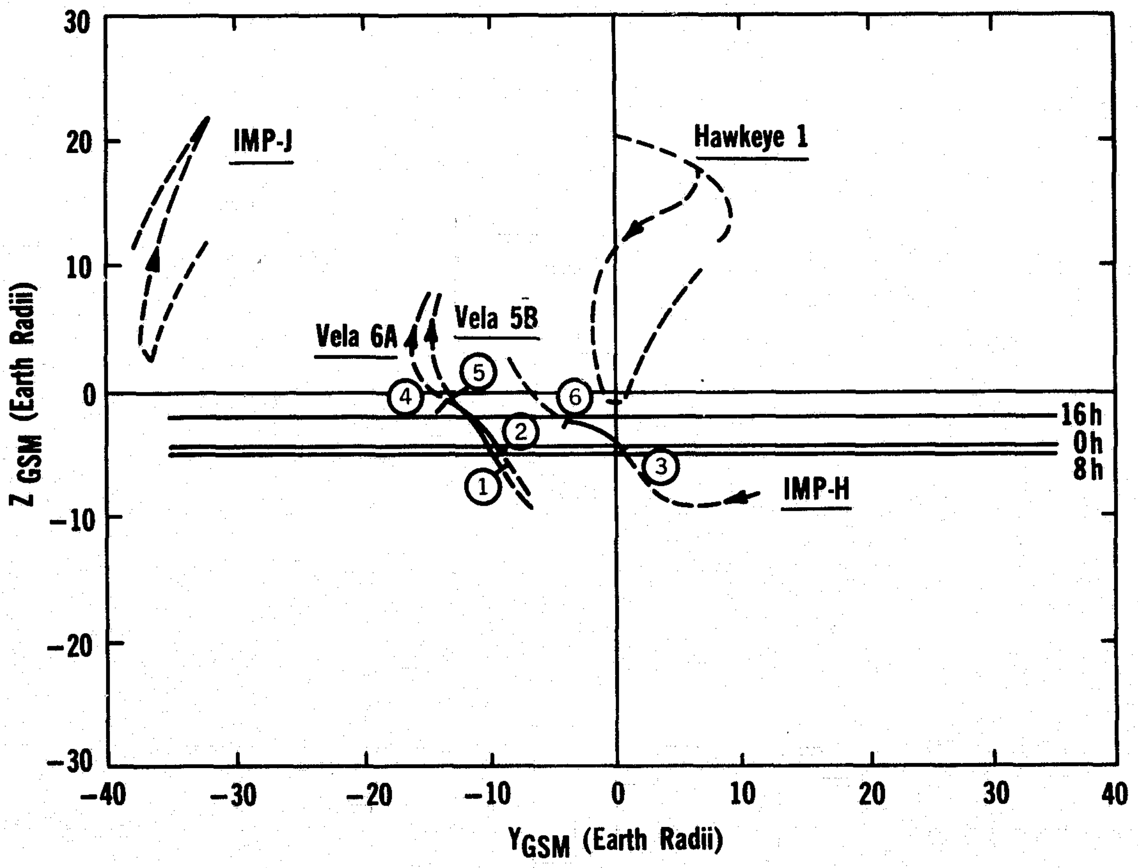
Time	Sat.	Direct.	Lat. (deg)
341/12 h	Hawkeye 1	Close Approach	71.0

Magnetopause Crossings

Time	Sat.	Direct.	Lat. (deg)
341/13.5 h	IMP-H	In	−18.4
341/13.5 h	Vela 5B	In	−51.5
343/6 h	Vela 6A	Out	27.0
343/8 h	Hawkeye 1	Out	55.3
343/7 h	Vela 6B	In	−49.3

Figure 112

TIME PERIOD 17: 1976 Day 341/12h - 343/8h



Code	Time	Vela 5B Alt. (E.R.)	IMP-H Alt. (E.R.)	Vela 6A Alt. (E.R.)
1	342/8 h	17.4	35.1	17.4
2	342/12 h	17.2	34.7	17.4
3	342/17 h	17.0	34.3	17.4
4	342/19.5 h	17.0	34.1	17.3
5	342/21 h	16.9	33.8	17.3
6	342/24 h	16.9	33.7	17.3

Figure 113. Time Period 17

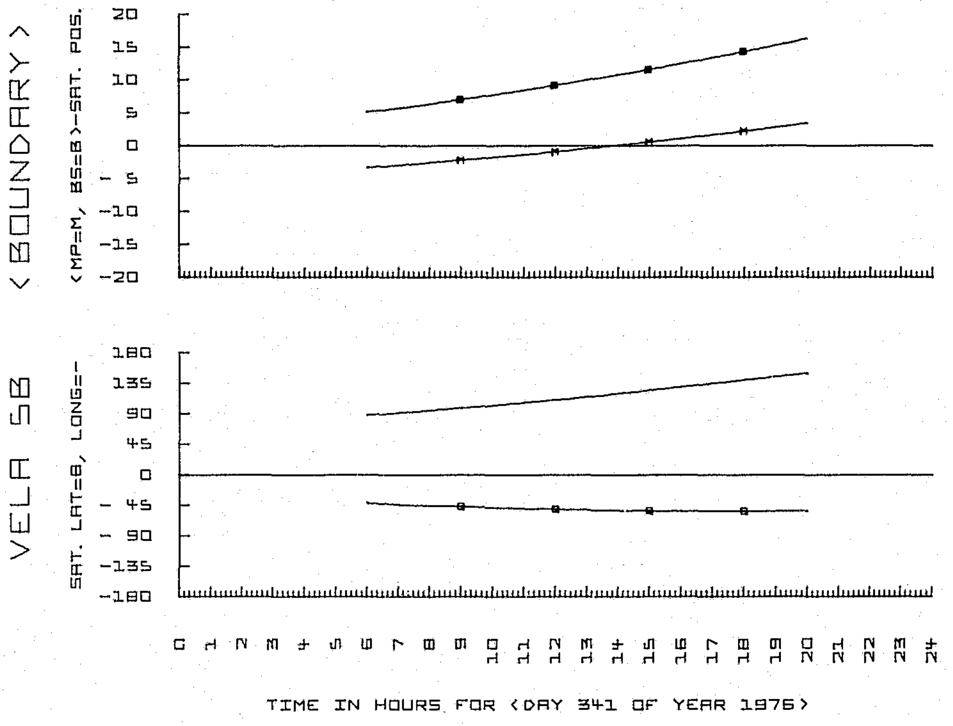


Figure 114. Time Period 17

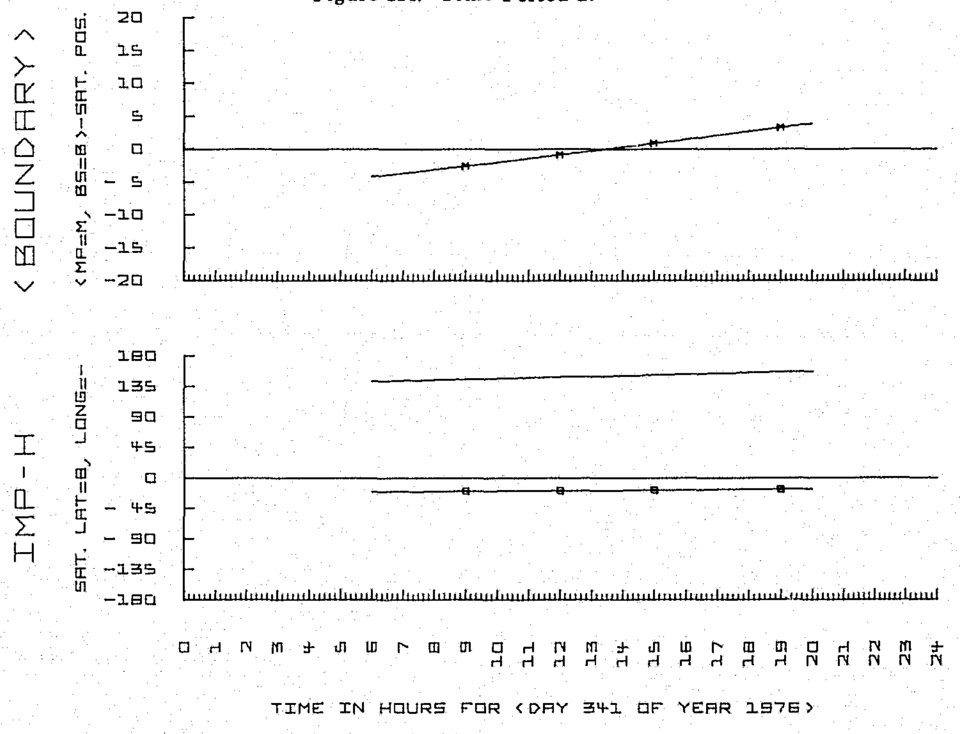


Figure 115. Time Period 17

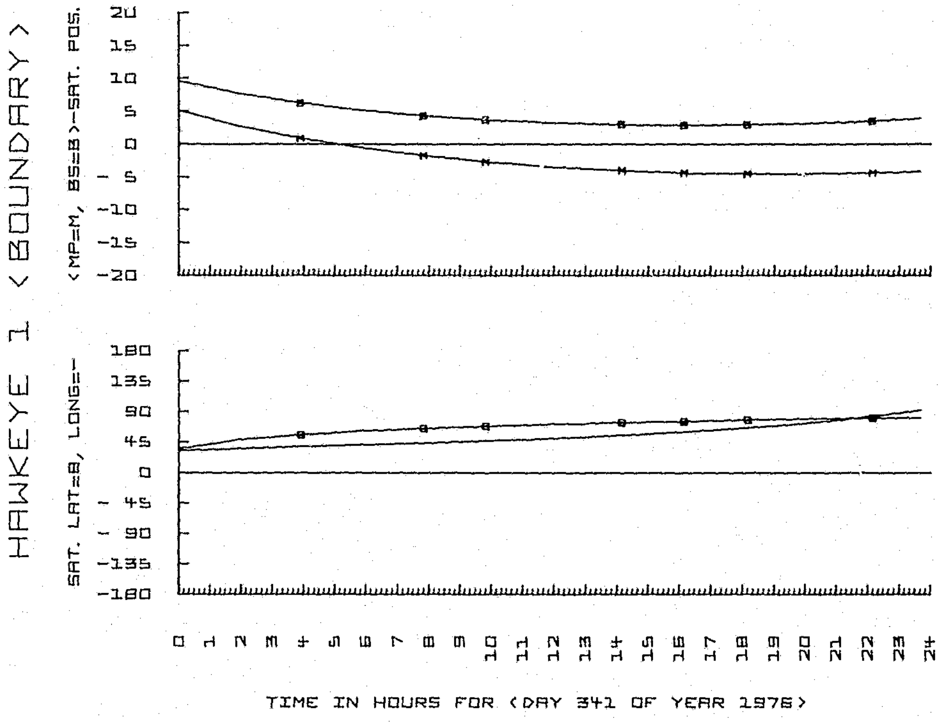


Figure 116. Time Period 17

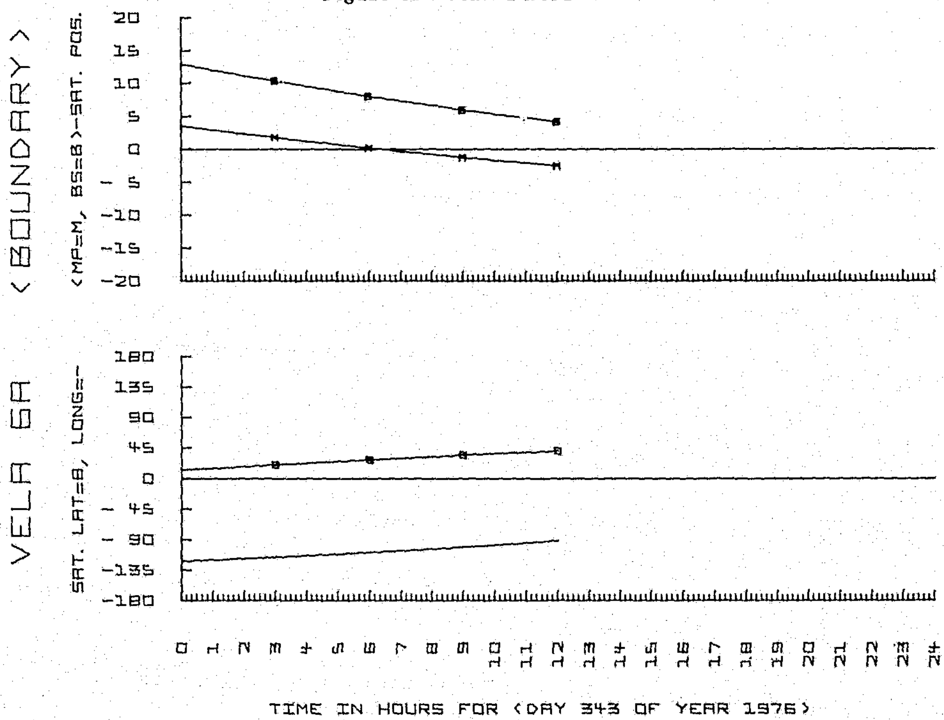


Figure 117. Time Period 17

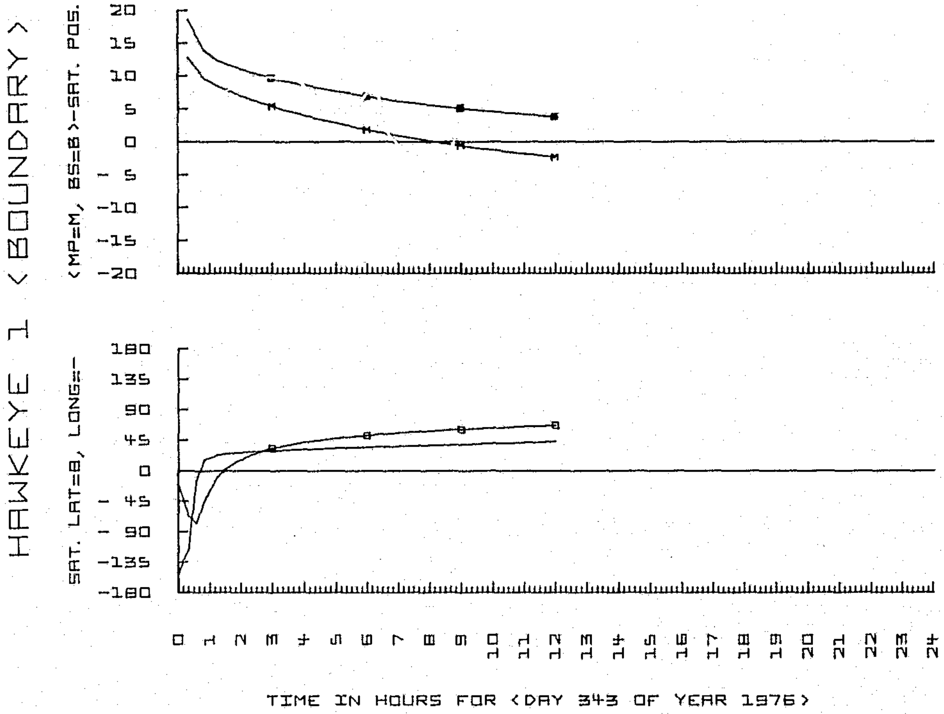


Figure 118. Time Period 17

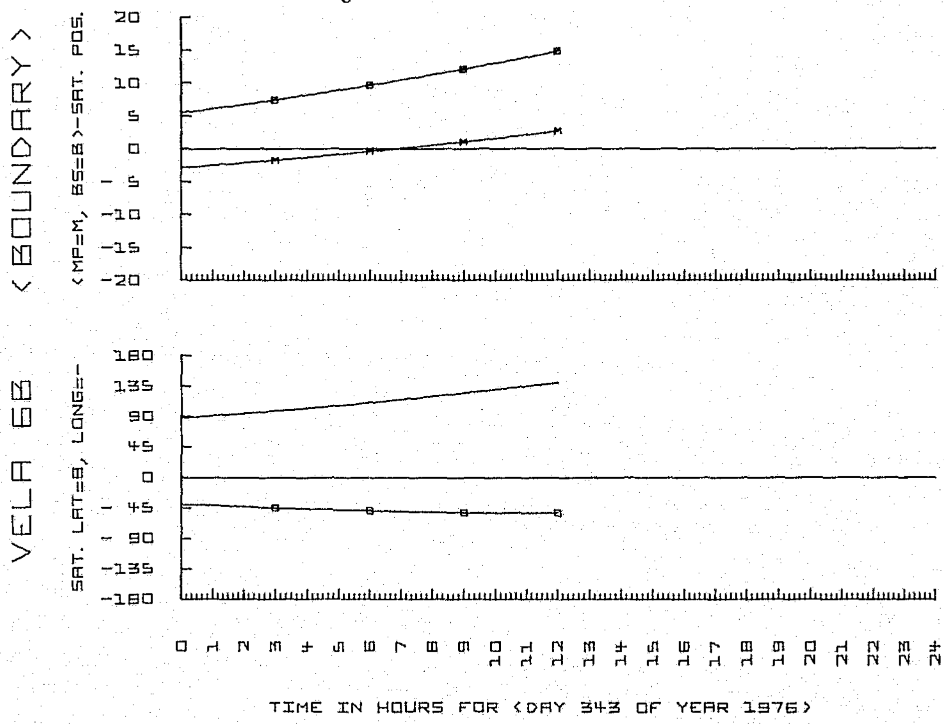


Figure 119. Time Period 17

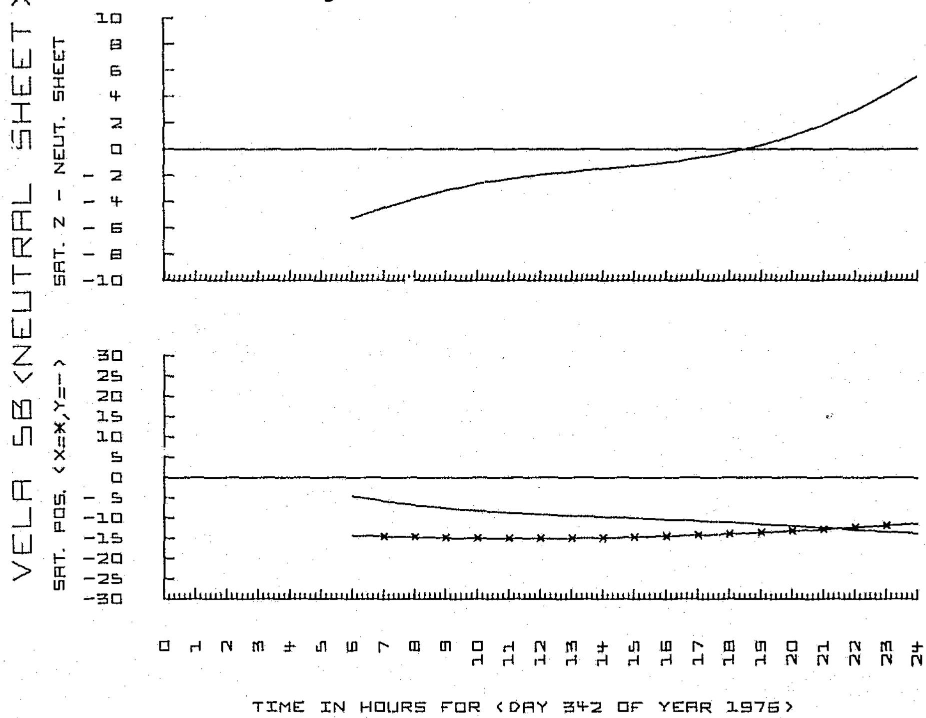


Figure 120. Time Period 17

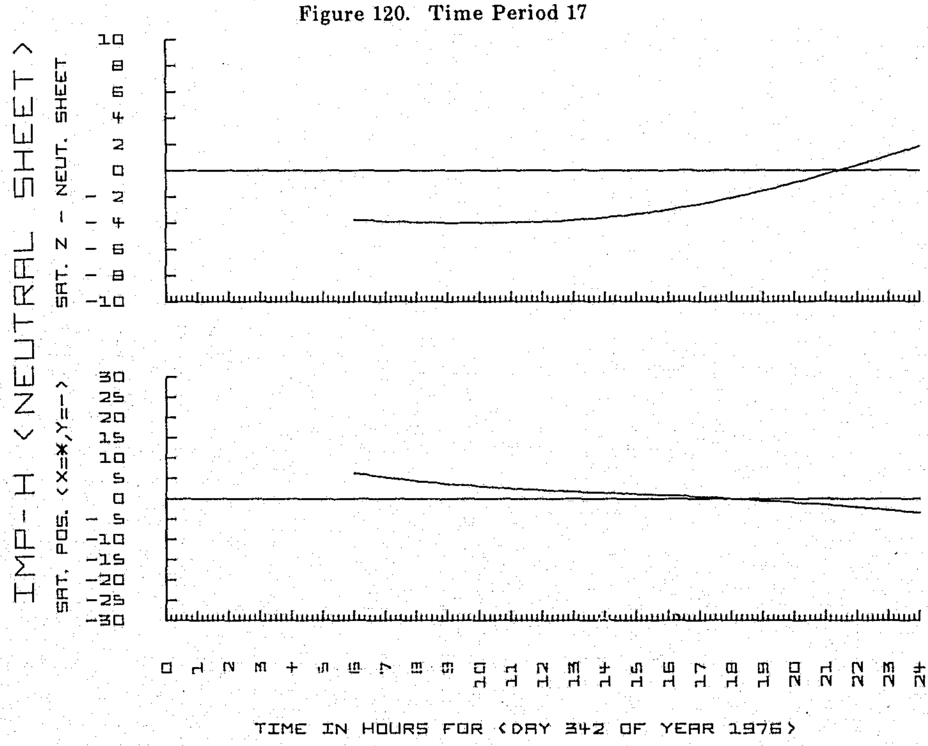


Figure 121. Time Period 17

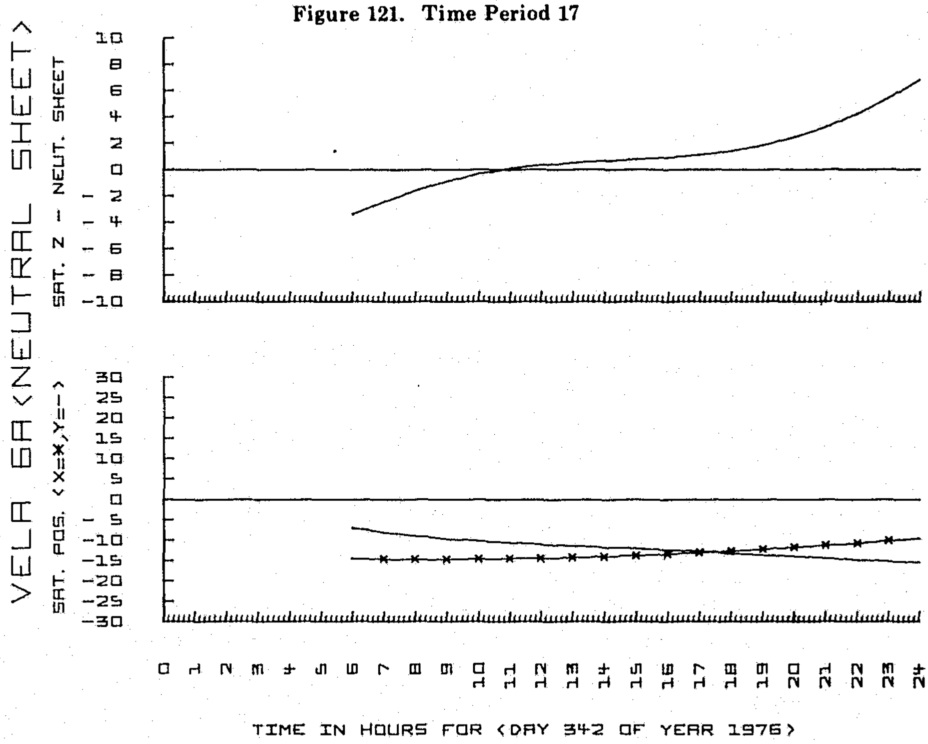
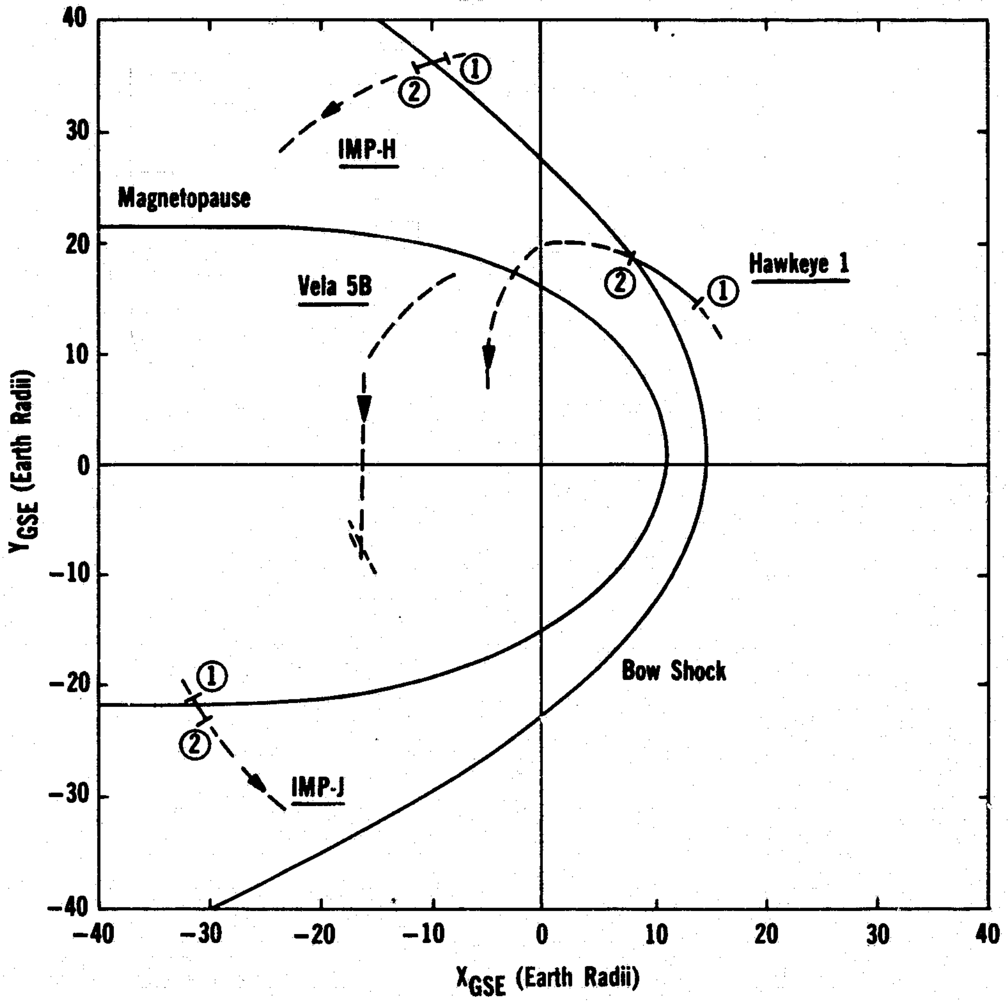


Figure 122

TIME PERIOD 18: 1976 Day 365/7h - Day 366/7h



Code	Time	Vela 5B	Vela 6A	IMP-H	IMP-J	Hawkeye 1
1	365/7h	HT	HT	I	Sh	DS
2	365/11h	HT	HT	NS	NS	S

Bow Shock Crossings

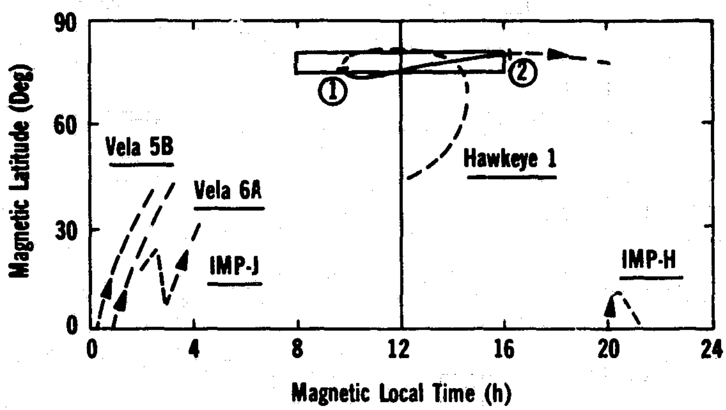
Time	Sat.	Direct.	Lat. (deg)
365/9h	IMP-H	In	−22.5
365/7h	Hawkeye 1	Close Approach	78.2

Magnetopause Crossing

Time	Sat.	Direct.	Lat. (deg)
365/7.5h	IMP-J	Out	−3.7

Figure 123

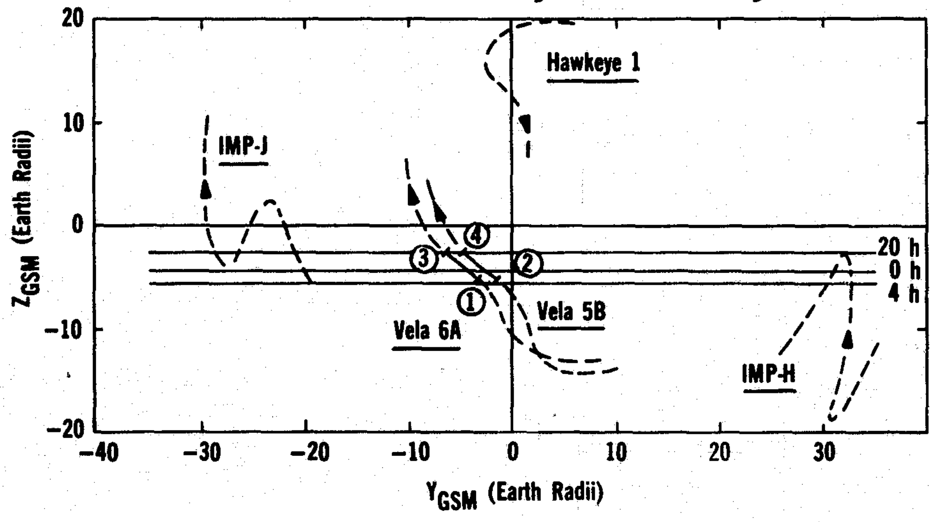
TIME PERIOD 18: 1976 Day 365/7h - Day 366/7h



Code	Time	Alt. (E.R.)
1	365/22h	16.3
2	366/6.5h	9.2

Figure 124

TIME PERIOD 18: 1976 Day 365/7h - Day 366/7h



Code	Time	Vela 5B Alt. (E.R.)	Vela 6A Alt. (E.R.)
1	365/20h	17.2	17.4
2	365/22h	17.1	17.4
3	366/0.5h	17.0	17.4
4	366/1.5h	17.0	17.3

Figure 125. Time Period 18

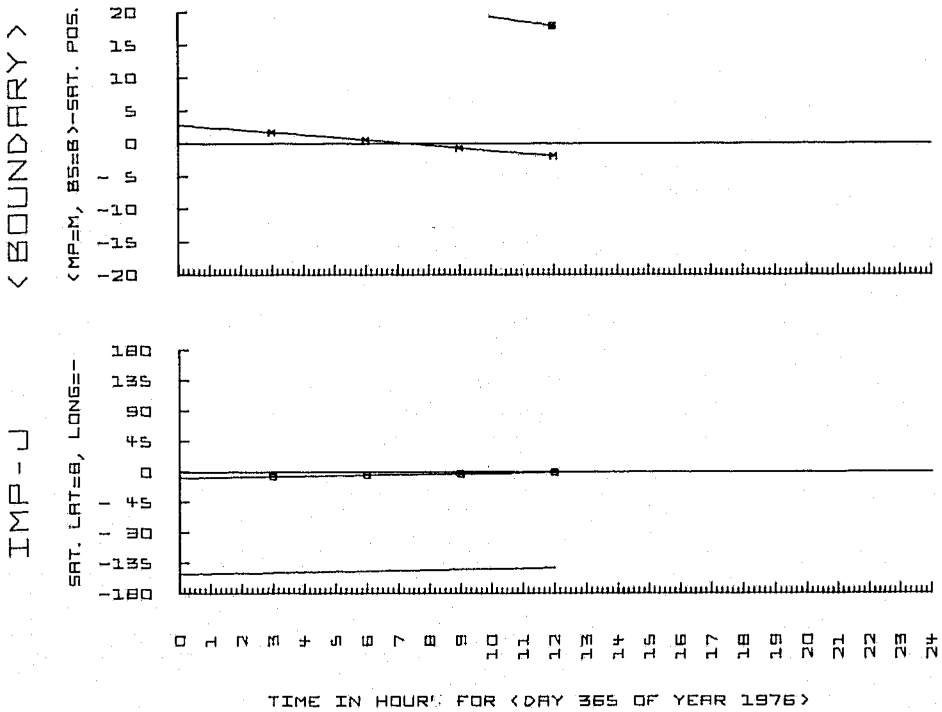


Figure 126. Time Period 18

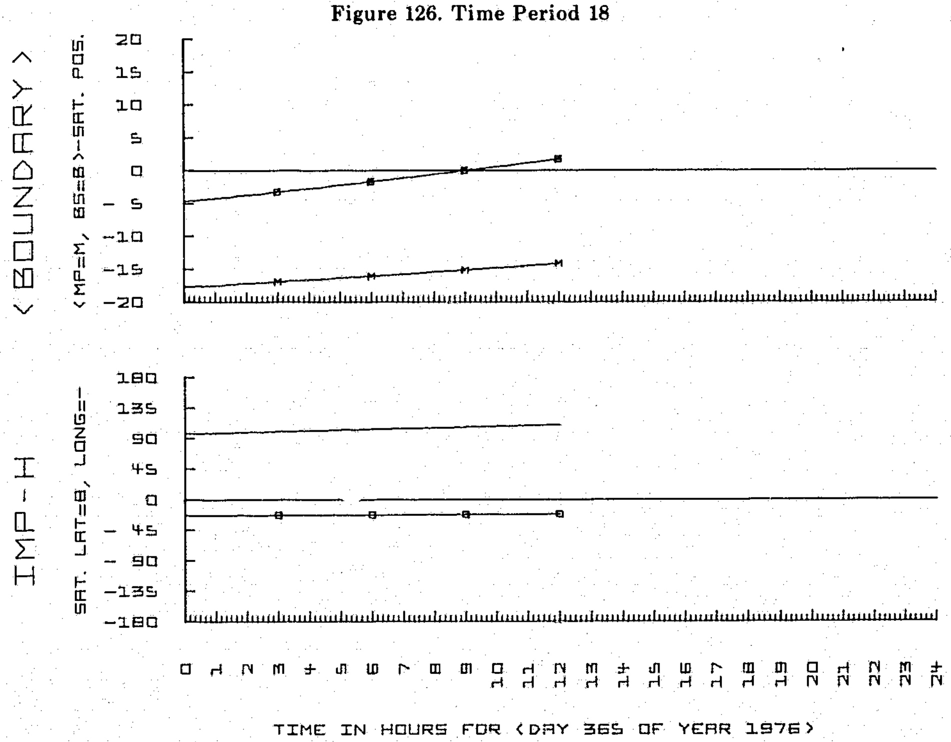


Figure 127. Time Period 18

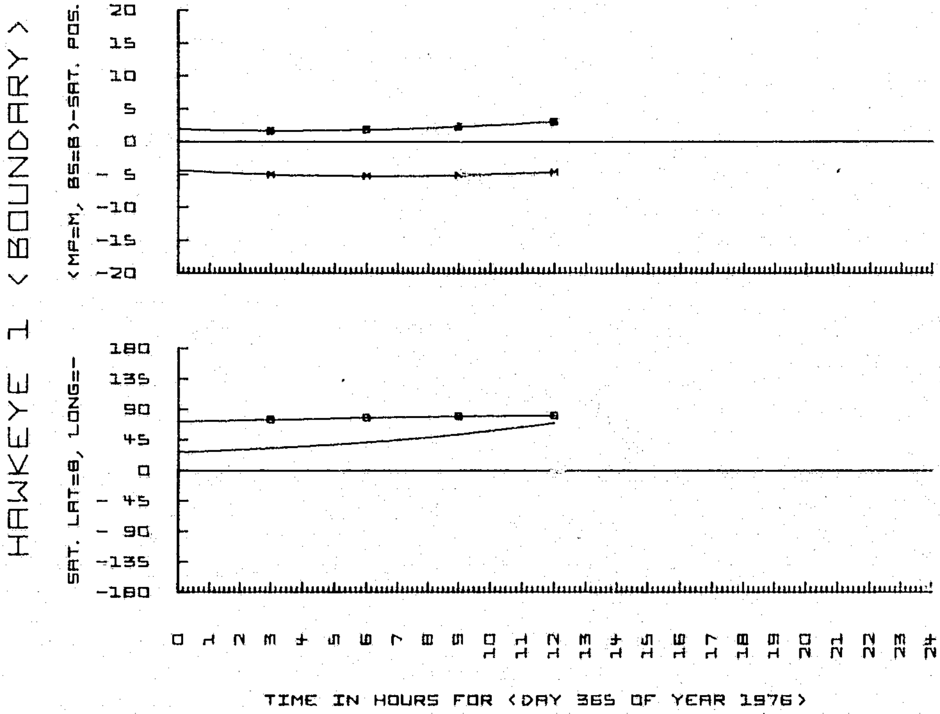


Figure 128. Time Period 18

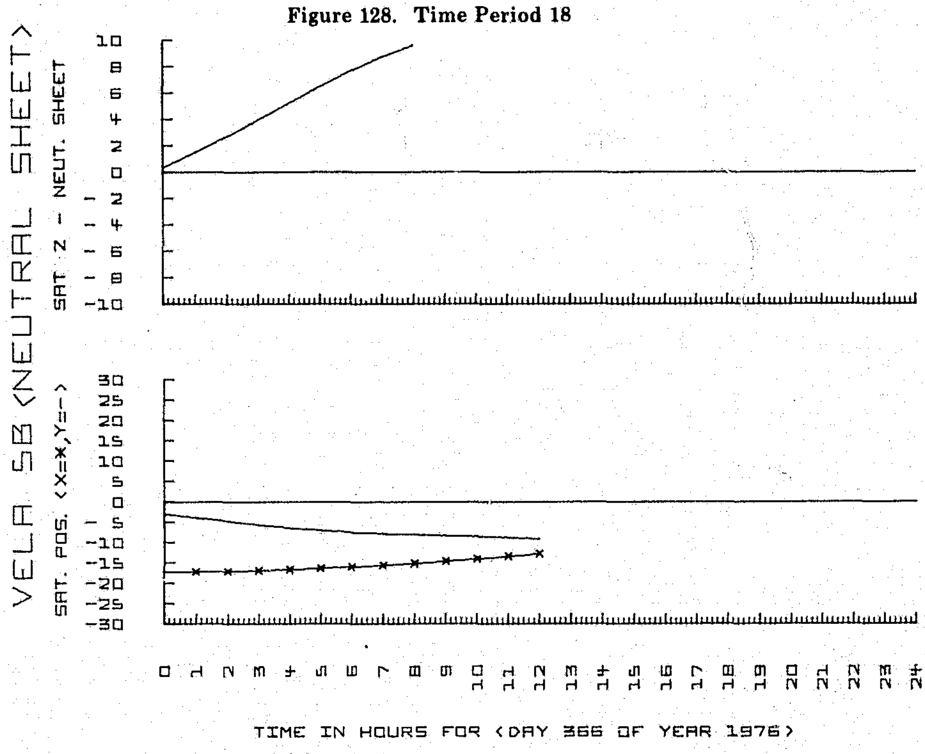


Figure 129. Time Period 18

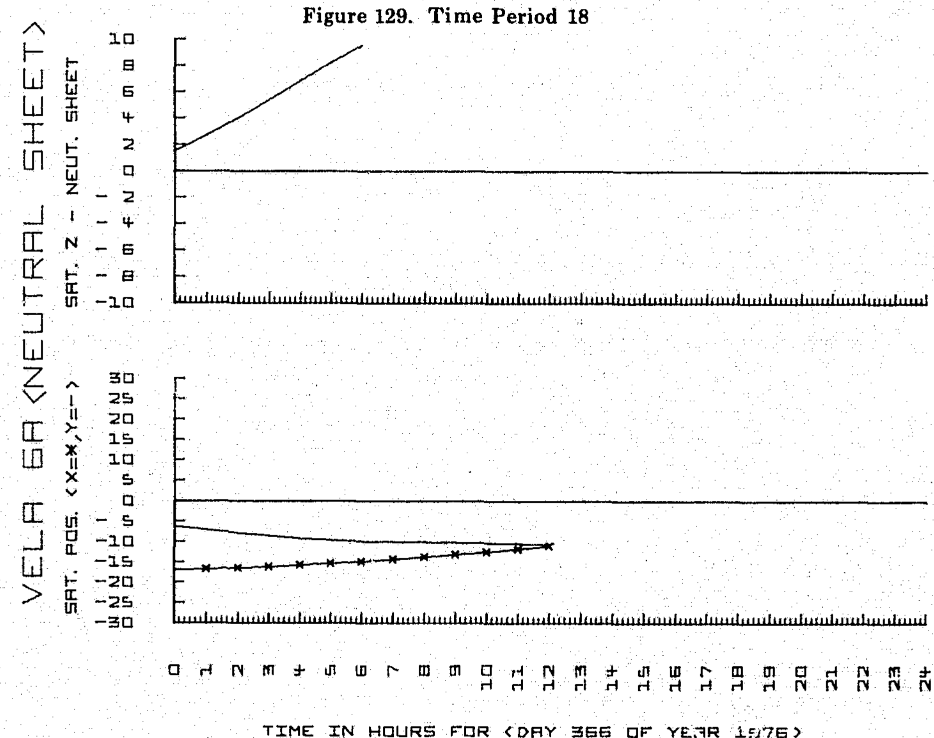


Figure 130. Local Time for Operating Geosynchronous Satellites

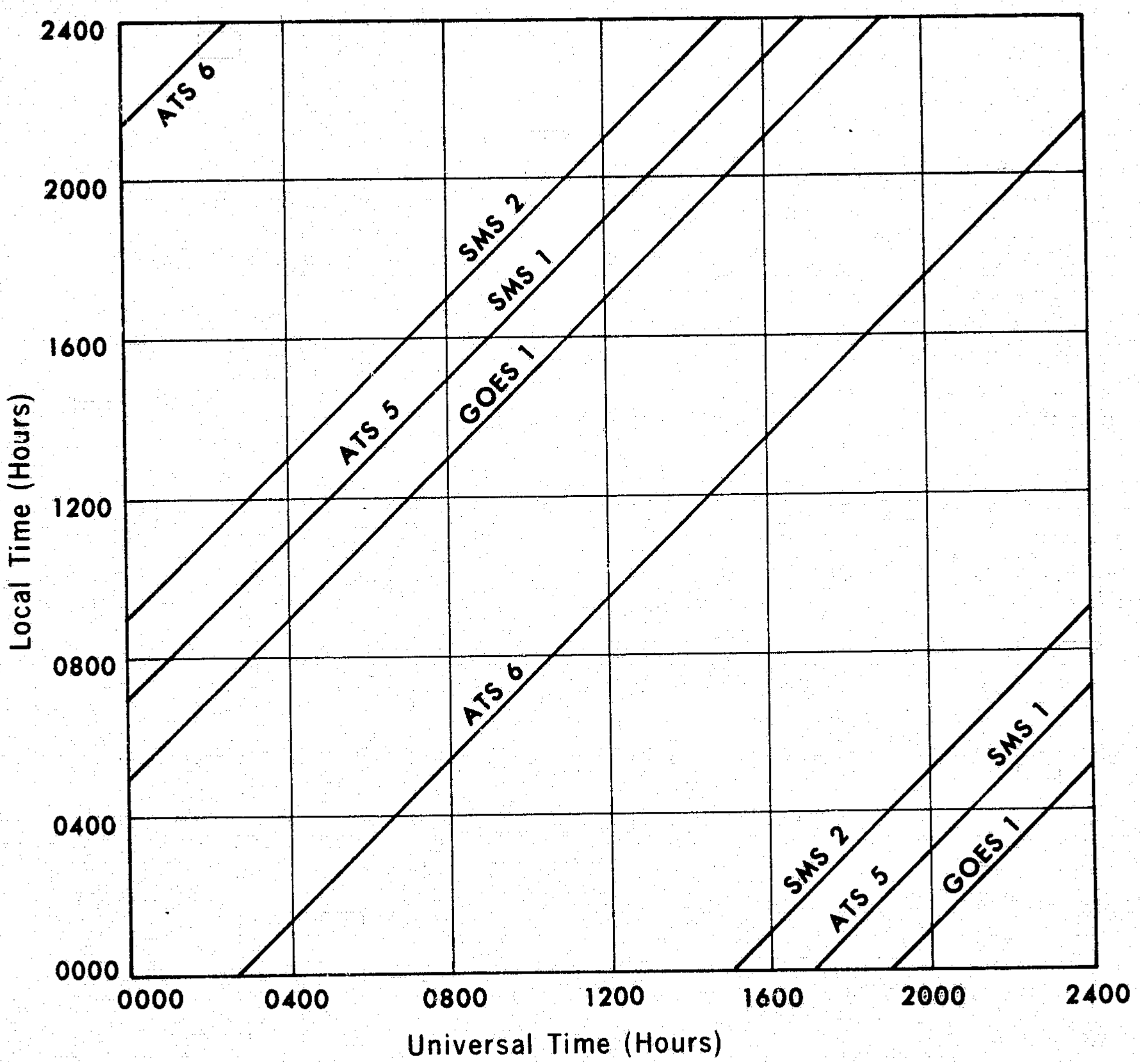


Figure 131. International Geophysical Calendar for 1976

With Special IMS Spacecraft Periods Indicated

JANUARY

S	M	T	W	T	F	S
				1*	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28*	29*	30	31

FEBRUARY

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29						

MARCH

S	M	T	W	T	F	S
	1	2*	3*	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30*	31*			

APRIL

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28*	29*	30	

MAY

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26*	27*	28	29
30	31					

JUNE

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23*	24*	25	26
27	28	29	30			

JULY

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27*	28*	29	30	31

AUGUST

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25*	26*	27	28
29	30	31				

SEPTEMBER

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22*	23*	24	25
26	27	28	29	30		

OCTOBER

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20*	21*	22	23
24	25	26	27	28	29	30
31						

NOVEMBER

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23*	24*	25	26	27
28	29	30				

DECEMBER

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21*	22*	23	24	25
26	27	28	29	30	31	

17 Regular World Day (RWD)

18 Priority Regular World Day (PRWD)

21 Quarterly World Day (QWD) also a PRWD and RWD

2 Regular Geophysical Day (RGD)

29 Day of Solar Eclipse

28* Dark Moon Geophysical Day (DMGD)

5 6 World Geophysical Interval (WGI)

[5 Day with unusual meteor shower activity, Northern Hemisphere

27] Day with unusual meteor shower activity, Southern Hemisphere

20 21 Airglow and Aurora Period

Special IMS Spacecraft Periods

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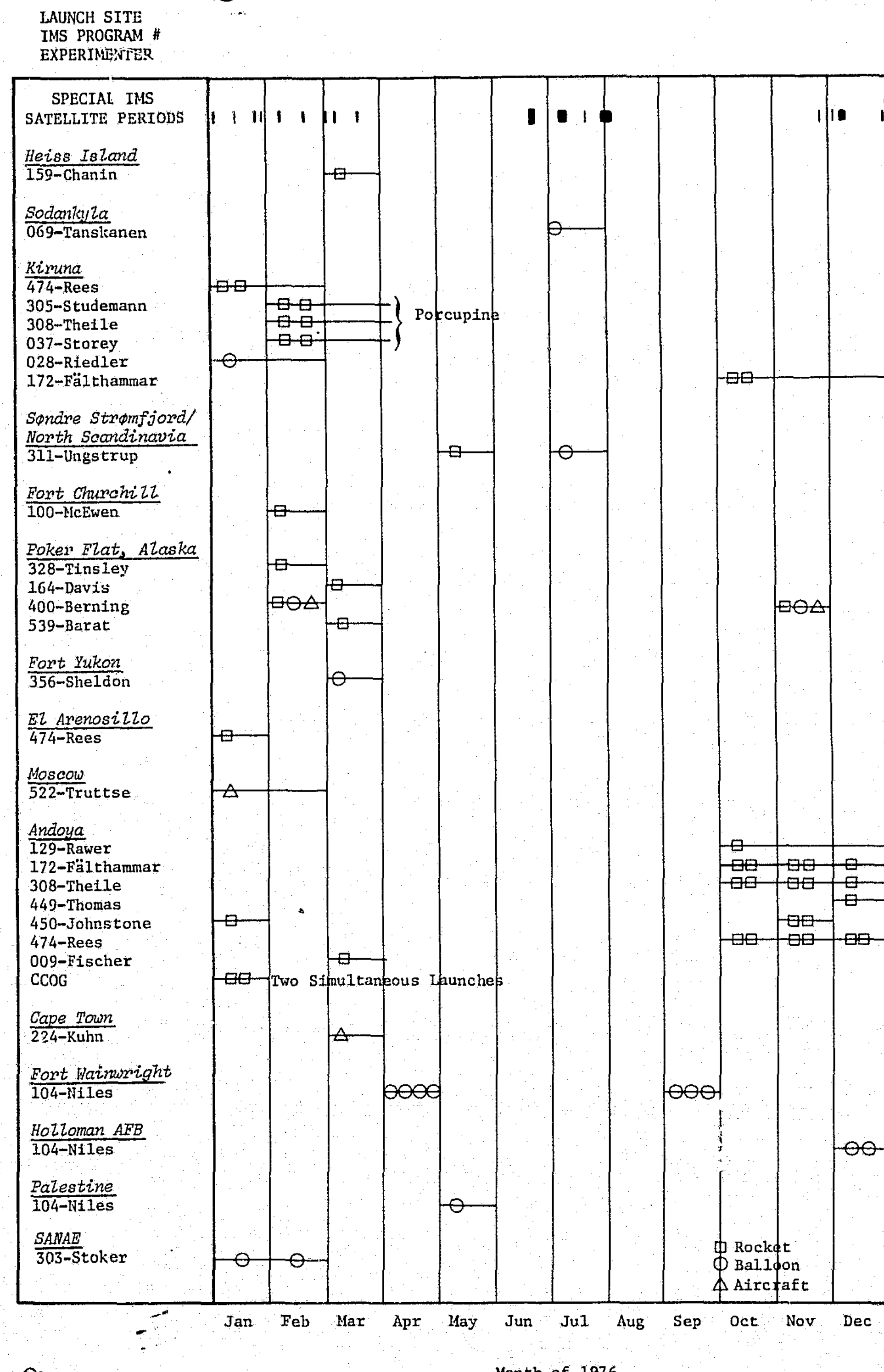
Figure 132. IMS Calendar for 1976



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